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Fall minority report

AWAKENINGS First drug to reverse Parkinson's


News
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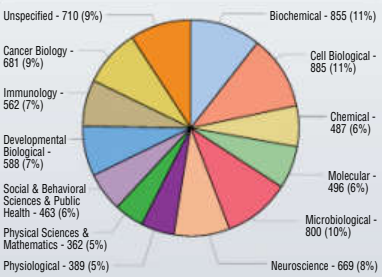
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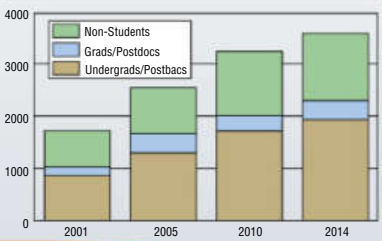
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PHANIE/ALAMY

Deep trouble?

The failure of two big depression trials should only be a setback

THIS week will see the first live televised surgery to implant electrodes into the brain of a person with Parkinson's disease. It sounds risky, but the procedure is so routine that the chance of anything going wrong is slender. Tens of thousands of people with Parkinson's have had it done, for a therapy called deep brain stimulation (DBS). For most, it is a life-changing operation.

When DBS was being developed for Parkinson's, people speculated about its potential for treating other neurological diseases, or even as a brain enhancement for healthy people. At the same time, there were warnings about overreach. More than a decade ago *New Scientist* quoted the developer of the technique, Alim-Louis Benabid of Grenoble University Hospital in France, as saying: "There is a risk of overuse and mispractice. I'm aware of that – and quite frightened." (24 July 2004, p 40). That future has now arrived. It isn't exactly frightening, but there is more than a hint of overuse.

On the plus side, DBS has been used to alleviate the symptoms of Alzheimer's and obsessive-compulsive disorder, and reset the metabolism of people with obesity. However, as the recent failure of two large clinical trials of DBS for depression attests, for disorders other than Parkinson's it is still very much in the experimental stages (see page 38). We still don't even really know why it alleviates Parkinson's symptoms, or why it causes some rather strange side effects.

The failure probably spells the end for some of the more medically and ethically dubious uses of DBS, such as to control the sexual urges of paedophiles.

It would be a shame, however, if the failures close off what is still an interesting avenue for treating depression. The World Health Organization rates it as the globe's leading cause of disability, and its burden is on the rise.

There were some promising early results in depression. It is surely time for DBS researchers to take stock, dust themselves down and try again. ■

Canada sees reason

SO FAREWELL then Stephen Harper, the now ex-prime minister of Canada. Under his 10-year premiership a country that once enjoyed a deserved reputation as a scientific and environmental leader became something of a pariah. It tore up its climate pledges, cut science spending and notoriously tried to silence scientists employed by the federal government. Journalists wanting to talk to them faced a Byzantine and sometimes Kafkaesque system of vetting before being granted access.

In 2013, a survey of more than 4000 federal scientists found that 90 per cent felt they were not allowed to speak freely to the media, and 24 per cent said they had been directly asked to exclude or alter information. In a modern democracy, that's a disgrace.

The incoming prime minister, Justin Trudeau, has already promised to end the media gag. Let us hope he rapidly reverses Harper's regressive policies on science and the environment and restores Canada's position as an enlightened force for good.

Canada's anti-science lurch has been mirrored in other countries recently, most notably Australia and, to some extent, in the UK's science funding. Let us hope that its new direction will also be mirrored in these places. ■

Promise of freer Canada

WINDS of change are blowing in Canada. The Liberal party has surged to victory in the general election, winning a majority in parliament.

The result brings an end to 10 years of rule by the Conservative party, which drew criticism for its policies on science and the environment, most notably for muzzling publicly funded scientists and pulling out of the Kyoto protocol in 2011 as part of a rollback on climate action.

New prime minister Justin Trudeau has promised to let scientists speak openly about their work. He plans to appoint a chief science officer to protect the independence of federal scientists and keep the discussions transparent.

"Under the previous government, we saw a climate of fear where some government scientists were not allowed to talk to journalists about their research results," says Rachael Jolley, editor of *Index on Censorship* magazine. "We hope that the new government will be more committed to making sure its citizens are fully informed about science and research."

Trudeau has also promised to take climate change seriously after years of inertia under the Conservatives. He has promised to establish a novel climate change framework by February 2016 that will include a plan to phase out fossil fuel subsidies. The Liberals have committed to investing $6 billion in green infrastructure over the next four years, and $2 billion in a low-carbon economy trust that will fund projects to cut carbon emissions.



KEVIN VAN PAASSEN/BLOOMERG/GETTY

Trudeau pledges a greener Canada

Rethink on drugs?

IT'S a hint of a truce in the war on drugs. On Monday, businessman Richard Branson wrote in a blog post that the United Nations Office on Drugs and Crime (UNODC) was about to recommend that governments decriminalise all illegal drugs. A long-time advocate of reforming drug laws, Branson said he "could not be more delighted" that a paper giving this advice would be issued at this week's International Harm Reduction Conference in Kuala Lumpur, Malaysia.

"Some day, governments might need to decide whether to remove penalties for drug use"

The UNODC was then forced to publish a statement saying that the briefing paper Branson alluded to is "neither a final or a formal document", and that there had been an "unfortunate misunderstanding" regarding the paper's intent. It also states that the paper remains under review.

If such a recommendation were to emerge, governments across the globe would need to decide whether to follow the example of Portugal, which in 2001 got rid of penalties for the use of all drugs.

David Nutt, chair of the UK's Independent Scientific Committee on Drugs and former UK government adviser, says that he would fully support such a move by the UNODC. "For recreational drug users, criminalisation will do more harm than the drugs they use, and for addicts they need to be treated for the illness they suffer, not persecuted," he told *New Scientist*.

An analysis of the effects of Portugal's drug policy found that although there were small increases in adults' use of soft drugs such as cannabis, the use of "problematic drugs", in particular injectable ones like heroin, decreased. Portugal also has one of the lowest levels of drug use in Europe.

"Decriminalisation does not generally lead to increases in drug use or related harms," says Alex Stevens, professor of criminal justice at the University of Kent, UK.

Nano-infiltrators

CARBON nanotubes have turned up in the lungs of children living in Paris – the first time they have been detected in humans.

Fathi Moussa and colleagues at the University of Paris-Saclay discovered nanotubes in samples of fluid and cells taken from the lungs of 64 asthmatic children.

The level at which they are present is unclear, as is their source – although they are used in some construction materials. Similar structures have also been found in dust and vehicle exhaust collected in Paris (*EBioMedicine*, doi.org/8jp).

Mouse studies show that injected nanotubes can cause immune reactions similar to those produced by asbestos, although the consequences for human health are not yet known.

If we are breathing in nanotubes, it's probably nothing new and fossil fuels are a probable source, says Jonathan Grigg at Queen Mary, University of London. "I guess we've been breathing them for a very long time," he says.

Russia seeks help for moon base

COULD humans live on the moon? The European and Russian space agencies are planning a trip to find out. ESA has announced it will contribute a drill and other instruments to Roscosmos's Luna 27 lander, an uncrewed craft set to touch down on the moon in 2020. The probe will search for water and other materials that could eventually support a settlement. Russia's return to the moon, following the end of Soviet exploration in the 1970s, has been in the works since the late 1990s, but partnerships with China, Japan and India fell through.

Now Russia has backing from Europe. The new head of ESA, Johann-Dietrich Wörner, has called for a collaboration to make a settlement on the moon, modelled after the International Space Station. If this first mission is a success, it could be followed by lunar rovers and a mission to bring samples of moon rock back to Earth.



Malaria vaccine

THE world's first malaria vaccine is expected to get the WHO's seal of approval.

Malaria kills half a million African children under 5 every year. In April, a trial of the vaccine

"Scientists are expected to recommend the first malaria vaccine – but only in some circumstances"

RTS,S, made by GlaxoSmithKline, found that children over 5 who had three doses plus a booster 18 months later had 36 per cent fewer cases of malaria in the next four years. Cases fell 26 per cent in babies vaccinated the same way.

The trial was carried out in seven African countries along with other measures to combat the disease, such as bed nets and prompt diagnosis and treatment. Although the vaccine offers only modest protection, its benefits should be even greater in African communities with less access to these measures.

If the drug is approved, African countries will have to decide whether they can ensure its proper adoption. If children do not receive the booster, studies show they may be at greater risk of severe malaria after two years than children who get no vaccine at all. The evidence will be presented to the WHO at a meeting in Geneva, Switzerland, this week.



ESA

Home from home

FRANCIS R. MALASIG/EPA



A taste of things to come?

Typhoon flooding

AT LEAST 20 people are reported dead and more than 100,000 have fled their homes as a tropical cyclone – the remnants of typhoon Koppu – creeps slowly across the northern Philippines.

On Sunday morning the typhoon hit Casiguran in Aurora province, toppling trees and power lines and causing flooding. It was downgraded to a tropical storm on Monday, but continued to drive heavy rains on the island

"This year's El Niño could increase the chance of typhoons developing and make them even wetter"

of Luzon. Some models are predicting that 1 metre of rain will fall in some areas, according to the BBC weather service.

Half a million people have been affected and more than 4000 houses have been destroyed, according to the country's Department of Social Welfare and Development's twitter account. Over 100,000 people have been housed in shelters, it says.

In 2013, the Philippines was hit by typhoon Haiyan, one of the strongest tropical cyclones on record, killing about 6000 people.

The role of global warming in these storms is unclear. But the current monster El Niño might be increasing both their chance of developing, and how wet they are, says Wenju Cai at CSIRO, Australia's government research agency.

El Niño causes warm water to spread out east along the equator. This could encourage typhoons to originate further east, spending more time over the ocean and becoming stronger before they make landfall, says Cai.

Alaska up in smoke

THIS year has been the second worst ever for wildfires in Alaska, with three record-breaking years since 2004. If the trend keeps up, more and more of the forest will be pumping carbon into the atmosphere, instead of soaking it up.

This means that climate scientists may need to revise their assumptions that fires have stayed the same throughout history.

Ryan Kelly at consulting firm Neptune and Company and his team reran climate models based on new data from Yukon Flats in central Alaska. Instead of storing carbon steadily, the Yukon Flats have probably been a net exporter of carbon into the atmosphere since 1950 (*Nature Climate Change*, doi.org/8jf). "It's not just a little problem," says Kelly. "It totally changes the conclusion from the model."

60 SECONDS

Booze bill

Hitting the bottle cost the US $249 billion in 2010, according to a study of binge drinking, underage drinking and imbibing while pregnant. Most costs were due to lost productivity at work, crime and medical treatments. Binge drinking was responsible for 70 per cent of these costs (*American Journal of Preventive Medicine*, doi.org/8dd).

Seagrass carbon bomb

Huge amounts of carbon buried in the seabed under seagrass for millennia may escape within decades if the seagrass is disturbed by coastal development. Restoring the seagrass can help cap the carbon, but slow recovery rates mean transplantation could speed up the process (*Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2015.1537).

The hunger fumes

Not only is pollution bad for our health, it is also stinking up bees' path to flowers. Nitrogen oxides from diesel exhaust confuses bees, stopping them from detecting several flower smells that help steer bees to their food (*Journal of Chemical Ecology*, doi.org/8jj).

Pretty pics

NASA has launched a website to showcase images from its Deep Space Climate Observatory, which constantly snaps Earth from a distance of 1.5 million kilometres to monitor global changes. NASA promises at least a dozen new colour pictures of our planet every day at epic.gsfc.nasa.gov.

Fukushima legacy

Japan's ministry of health, labour and welfare has announced the first case of cancer that might be linked to Fukushima clean-up work. The man, who worked at the stricken plant for more than a year, was diagnosed with acute leukaemia and has been offered compensation, according to government officials.

Drug reverses Parkinson's

A trial of an anticancer medication has helped bedridden people walk and talk for the first time in years, finds **Jessica Hamzelou**

IT IS the first drug that seems to directly target the causes of Parkinson's disease. People taking part in a safety trial have had their symptoms reversed, allowing them to talk, get out of bed and feed themselves once again. Although there are already several treatments for the symptoms of Parkinson's, this could be the first to provide substantial, lasting relief.

"We've seen patients at end stages of the disease coming back to life," says Charbel Moussa of Georgetown University Medical Center in Washington DC, who led the trial.

The drug, nilotinib, is already approved to treat cancer – it blocks a protein that drives chronic myeloid leukaemia. But it also blocks a protein that interferes with lysosomes – cell structures that destroy harmful proteins.

Moussa thinks nilotinib can free up these lysosomes, which he calls the brain's "garbage disposal system", to do a better job of clearing out the accumulation of proteins in the brain that is associated with Parkinson's disease. It is this build-up of proteins that is thought to trigger the death of brain cells that make the molecules like dopamine needed for movement and other functions.

Tests in animals showed promise, so Moussa, his colleague Fernando Pagan and their team set up a small trial of 12 volunteers with Parkinson's disease or a similar condition called dementia with Lewy bodies. The trial was designed to test only the safety of the drug, which was given as a daily oral dose for six months.

All the volunteers were at an advanced stage of disease at the start of the trial. Three of them were unable to speak, and were enrolled in the study by relatives with power of attorney.

But once they started taking the drug, all the volunteers began to improve, some just three weeks later. One woman who was barely able to move her limbs at the start managed to feed herself after five months of treatment.

"We had people as stiff as a board at the start of the study who were walking around, sitting down and bending their legs by the end," says Moussa. "You could see the elation on their faces when they saw the improvement. There wasn't a dry eye in the room."

An awakening

Alan Hoffman, who first showed signs of Parkinson's in 1997, says the nilotinib trial changed his life (see "Winding back the years", left). Previously unable to get out of bed without help, within weeks of beginning the trial he was able to make the bed himself, and read a book for the first time in years.

Pagan compares the improvements to those in neurologist Oliver Sacks's book *Awakenings* – subsequently made into a film – in which he described helping people who had been paralysed for decades by sleeping sickness to move, walk and speak fluently again.

"They were more fluent in speech, and had a lot more energy," says Pagan. All three participants who were unable to speak had begun talking again by the end of the trial. "It was like an awakening for them," says Pagan.

Some volunteers found their drastic improvements to be too challenging, says Pagan. One woman dropped out of the trial because her husband struggled to cope with her new-found energy, he says. "When a person is not able to verbalise, it's actually easier to look after them," he says. "Once this woman started to talk, she argued with her husband – it caused more of a caregiver burden."

The drug was detectable in the cerebrospinal fluid of the participants, which shows that it

"We had people who had been as stiff as a board walking around and bending their legs"



AMELIE-BENOIST/BSIP/SPL

WINDING BACK THE YEARS

For Alan Hoffman, the first signs of Parkinson's disease appeared in 1997. His body became more rigid and he began to lose his sense of balance. Once a prolific reader, he struggled to focus on short magazine articles. "I couldn't get out of bed without my wife," he says. He had many falls, and considered taking his own life.

He tried a range of drugs, which alleviated some of his symptoms to varying degrees. In 2008, he had an electrode implanted into his brain, so that he could get deep brain stimulation to ease his body's rigidity (see page 38).

But deep brain stimulation does not stop Parkinson's disease from killing more brain cells and getting worse. So Hoffman agreed to participate in a six-month trial of nilotinib (see main story).

"I didn't notice any changes at first, but my friends started telling me that my speech was clearer," he says.

"By five weeks I really noticed the difference," he says. "I could start to do things like make the bed, or do the dishes. I read a book for the first time in years."

Hoffman's balance also improved and he fell less often, while his cognition scores increased too.

Since the trial ended, Hoffman thinks he has started to deteriorate again. His wife Nancy is hopeful that the drug's manufacturer Novartis will offer them further doses. "If not, we will find a way to pay for it," she says.

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A drug could help people walk again

makes it through the blood-brain barrier and into the brain. The team also monitored the tau, amyloid beta and alpha-synuclein proteins that accumulate as part of Parkinson's disease, and found that the levels of these proteins either stabilised or fell in all participants. At the same time, dopamine levels increased. Those taking the highest dose of the drug showed the biggest changes.

Pagan presented the results on 17 October at the Neuroscience 2015 meeting in Chicago. By one measure, participants' cognition improved by an average of around five points, on a scale of 30.

While nilotinib causes unpleasant side effects in people who take high doses of it for leukaemia, much lower doses were used in this trial and the team saw no unwanted effects.

Graham Kerr at Queensland University of Technology in Brisbane, Australia, says the results are striking. "The new treatment certainly appears to alleviate symptoms of Parkinson's as well as cause reduction in biomarkers associated with disease progression," he says.

The team thinks nilotinib is the first drug that can target the root cause of Parkinson's disease and provide more than temporary relief. Other neurologists are excited by the results, but warn that no firm conclusions can be drawn until the drug has been tested in a larger trial with a control group taking a placebo.

"It seems too good to be true. I dearly hope I am wrong," says Carl Clarke of Sandwell and West Birmingham Hospitals NHS Trust, UK.

"If it can really reverse Parkinson's, we'd have reached a major milestone, but I'm sceptical," says Kallol Ray Chaudhuri at King's College London. "I'd say 'watch this space'."

There have been false dawns for Parkinson's before. A compound thought to encourage the growth of new brain cells – GDNF – received a lot of interest after promising animal experiments, and evidence suggesting it worked in a small number of people. However, no one has yet managed to replicate the effects in larger, placebo-controlled clinical trials.

"They were brighter and more fluent in speech. It was like an awakening for them"

The placebo effect can make a huge difference to symptoms of Parkinson's disease, says Arthur Roach, director of research at the charity Parkinson's UK. "We can't yet say that patients will benefit." He says a person's symptoms can also naturally vary by a large degree, for example at different times of day.

Moussa's team is now enrolling people with a range of disorders that involve accumulating brain proteins, including Alzheimer's disease and amyotrophic lateral sclerosis, for a larger, placebo-controlled trial.

Sadly, the effect of nilotinib doesn't seem to last once people stop taking it, and when the trial ended, they started to deteriorate again, says Moussa. Many have since tried to get hold of the drug themselves, but it costs a whopping $10,000 a month.

"One woman sold her car to buy the drug for her husband," says Moussa. Pagan is in discussions with manufacturer Novartis, hoping that the participants can be offered continued treatment at a reduced cost on a compassionate basis, through a procedure the company already uses to help people with cancer afford their medication. "We've been working on it for three months," says Pagan, "and hope to have an answer soon." ■

FIELD NOTES GCHQ, Cheltenham

Visiting the UK's digital spooks

Jacob Aron

I APPROACH a gatehouse beside a tall metal fence bristling with warnings and barbed wire. Few reporters get inside the UK's Government Communications Headquarters (GCHQ), and it takes three ID checks and several security gates, plus handing over my phone and tablet, before I find myself in front of the agency's giant stone emblem. The building is in the shape of a giant doughnut, but I've only penetrated the outer glaze.

I have been invited here for the launch of a new biography, *Prof: Alan Turing Decoded*, written by his nephew Dermot Turing. Alan Turing was one of the leading second world war codebreakers at the proto-GCHQ Bletchley Park, and the modern day spooks hold him dear in their hearts. But the event, the first of its kind at GCHQ, strikes me as something of a PR stunt for an agency that is now mostly associated with mass surveillance and the continuing revelations from Edward Snowden.

The drinks reception took place in an atrium kitted out as GCHQ's private museum. Multiple Enigma machines, the Nazi communications device cracked by Turing, and other crypto curios are on display, though nothing past the 1990s – presumably recent tech is still too secret. I could just about peer through the thick glass to see GCHQ staff in their offices, watching in bemusement at such a public event in their secretive halls.

As I mingled with GCHQ operatives, it became clear that Turing is genuinely beloved here. Staff apparently queued out of the building to get their own exclusive GCHQ edition of the book.

Many people told me that tales of Turing's escapades during the war inspired them to go into cryptography. Nearly everyone mentions Turing when they apply, says GCHQ historian Tony Comer, one of the few people authorised to speak to me on the record. "He is the emblematic member of staff working at Bletchley Park. Enigma stands for our history in the public mind."

Their stories were eerily familiar: I, too, grew up reading about Turing, and went on to study maths and cryptography at university. I considered applying for a job at GCHQ, eager to tackle the kind of problems Turing faced, but ultimately decided I wouldn't be able to handle keeping my friends and family in the dark.

But this conflation of war hero Turing with modern-day GCHQ troubles me. Is it a cover for an agency that has overstepped its bounds to spy en masse, if the Snowden revelations are to be believed? For example, the latest documents suggest that a GCHQ system called Karma Police aims to record the web history of every person on the internet.

"Turing's legacy to us all is the information revolution, but is this really what he would have wanted?"

It's clear that the constant accusations of mass spying have taken a toll on the staff here, who are at pains to distance themselves from such reports. Naturally, Comer doesn't recognise this malevolent portrayal of the agency. "Why would anyone who thought like Turing want to work at an organisation like that? We are not like that," he says.

But surely the released documents must contain some grain of truth. The nature of its work means GCHQ cannot respond to specific allegations, so it falls back on a position of "neither confirm nor deny" – but that seems increasingly untenable.

Turing had a clear-cut mission against the Nazis. Murkier modern threats come from within. If Snowden is to be believed, potential terrorists are found through bulk collection of the public's data, which may or may not be discarded later. Even members of parliament aren't immune, according to a ruling last week, despite a long-held doctrine that MPs' communications are off-limits to the security services.

The UK government is set to introduce laws that would enable wider spying powers and could outlaw some forms of encryption. It is difficult to accept these laws as a necessity in the fight against terror when we don't, and can't, know how they might be used against us.

Security services hoovering up ever more data increases the risk of wrongful arrests, such as in the case of Cerie Bullivant, an innocent man who spent two years under house arrest based on secret evidence. Turing's legacy to us all is the information revolution enabled by his pioneering work in computer science, but he couldn't have foreseen how much of our lives would be digitised. Is this really what he would have wanted?

As I leave GCHQ, retracing my steps through security, I no longer believe it is the cartoon villain it is sometimes portrayed as. But while its workings remain wrapped in secrecy, with lax public oversight, I'll never be able to afford it the respect I have for Turing. ■



ADRIAN SHERRATT / ALAMY STOCK PHOTO

How to get inside?

Super-black stuff to boost solar power

IT IS one of the blackest materials on Earth – but it can transform light into any colour you want. Simple to make, this chameleon material could one day boost solar power.

The world record for blackness is held by a material made from carbon nanotubes, which absorb 99.8 per cent of light when they are layered a millimetre thick.

But a nano-material consisting of tiny hammer-like shapes made of gold has achieved almost as much blackness – and researchers have discovered that with a small addition it can also reflect any colour.

Andrea Fratalocchi at King Abdullah University of Science and Technology in Saudi Arabia was inspired by beetles whose shells reflect all wavelengths of light, making them appear whiter than any artificial material. Wondering if the effect could be reversed, he designed a theoretical system that involved a tiny concave shell attached to an infinitely long tube designed to guide waves. If you could build such a structure, light would enter the shell, travel along the tube and vanish.

Using plasmonics – the study of materials that bend light along unusual paths – Fratalocchi approximated this design with gold nanorods.

At just a hundredth of a millimetre thick, the material absorbed 98.43 per cent of light. This level of light absorption means it could be painted onto other surfaces to turn light into heat. But when a simple dye is added to the material, its behaviour changes drastically: rather than absorbing the light energy and emitting it as heat, it emits it again as light, but at a single frequency. Everything in the visual and infrared spectrum is converted to the colour of the dye (*Nature Nanotechnology*, doi.org/8c9).

This could improve the efficiency of photovoltaic cells, which work best with particular frequencies of light, Fratalocchi says. "We have ongoing research in this direction," he says.
Michael Slezak ■



CAROLYN DRAKE / MAGNUM PHOTOS

Better get back in the yurt, Fido

It's in their genes: dogs originated in central Asia

SOMEWHERE in the heart of Asia was where dogs became man's best friend – according to the largest genetic study yet. The work looked at DNA from thousands of living dogs to piece together their ancestry and geographical origins.

"This is the first global study of genomic patterns of dog diversity," says Adam Boyko of Cornell University in Ithaca, New York, who led the team. "We find a clear pattern of genetic diversity focused on central Asia, suggesting the first domesticated dogs came from this region."

That departs from earlier studies that pinpointed Europe, although more recent work puts the location in southern China.

Boyko's team broke new ground by analysing DNA from so-called village dogs, which have lived alongside humans worldwide since dogs were first domesticated some 15,000 years ago. "They are very different from pure-bred dogs genetically because they are free-breeding, so in a genetic sense they are a natural population," says Boyko. Village dogs therefore carry a more authentic genetic signature of original dog populations than the modern-day breeds created in the past 200 years, mainly in Europe.

The team sampled DNA from 549 village dogs in 38 countries all over the globe. They also took DNA from 4676 pure-bred dogs of 161 breeds. By analysing

"Human settlement may have pushed wolves into scavenging, favouring tameness and smaller size"

185,805 genetic markers, the team was able to trace how all the animals were related, and so how they had spread (*PNAS*, DOI: 10.1073/pnas.1516215112).

They speculate that it was hunter-gatherers in central Asia, perhaps close to Mongolia and Nepal, who first domesticated dogs from grey wolves. A combination of increasingly dense human settlement, people becoming better hunters and climate change may have reduced the availability of prey and pushed some wolves towards scavenging, which favoured tameness and smaller size. This would in turn have reduced their hunting prowess, setting them on the path to domestication.

Other researchers have welcomed the team's finding, although some, such as Peter Savolainen of the Royal Institute of Technology in Solna, Sweden, dispute the precise site. "They are actually putting the origin very close to where we put it, just 1000 kilometres away in parts of Asia south of the Yangtze river," he says. "So I would say the consensus pointing to south and east, rather than central, Asia is quite clear."

Olaf Thalmann at Uppsala University in Sweden praises the scale of the study and says its conclusion is reasonable, but he doubts this is the final word. "The only way to shed further light on the topic is by analysing ancient remains," he says.

A consortium led by Greger Larson of the University of Oxford is now doing just that, comparing genetic and morphological data from hundreds of ancient dogs and wolves. We can expect further surprises, Larson says.
Andy Coghlan ■

INSIGHT Food allergies

Should babies eat solids earlier?

Clare Wilson

IS THIS one of the worst wrong turns in the history of parenting advice? Telling parents to delay when they start giving babies solid food might be contributing to the rise in allergies.

In the past, babies would often be eating solids around the age of 4 months. Many show an interest in food around this time, as well as developing a larger appetite. But since the World Health Organization published a report about a decade ago saying that babies should be exclusively breastfed until 6 months, countries like the UK and US have recommended parents hold off.

Not all parents follow the 6-month rule but healthcare staff and parenting websites tend to give out this advice. NHS leaflets warn parents that if they start weaning earlier than 6 months they must avoid potentially allergenic foods, like peanuts and eggs.

Yet this is at odds with the latest research from allergy specialists, says Elissa Abrams of the University of Manitoba in Winnipeg, Canada, in a review published this week (*Canadian Medical Association Journal*, doi.org/8jg). Several studies now suggest that, to stop babies developing food allergies, it's better for them to be exposed to solids from 4 months on. A trial published this year, for instance, showed the best way to ward off an allergy to peanuts is to give them to babies from 4 months of age.

Several kinds of studies have also suggested it could be beneficial for infants to encounter wheat, egg and cow's milk from a similar age, while there are also concerns that delayed weaning could cause anaemia, due to a lack of iron in breastmilk.

One criticism of the WHO's 6-month stance has been that it is more relevant to developing countries, where babies who are breastfed for longer are less likely to be exposed to contaminated water while they are at their most vulnerable.

But scientific thinking has changed too. Pregnant women used to be advised not to eat peanuts, until a 2013 study showed that this actually increased their babies' chances of developing a peanut allergy.

Is it time to change weaning advice? Despite her paper, Abrams sticks to the official Canadian Pediatric Society line to hold out until 6 months "because of the benefits of breastfeeding for babies and mothers".

Efforts to raise breastfeeding rates could be at the heart of the matter. The official line is that babies should be given only breastmilk – no formula – for the first 6 months of life, so telling parents they can give solids during this time could dilute this message. "Breastfeeding in the UK is so politicised that weaning has become drawn in," says one researcher who did not want to be named.

Some groups are giving different advice. The European Food Safety Authority says weaning at 4 months is fine. The British Dietetic Association says that while parents should aim for 6 months they can judge for themselves as different babies have different needs. "Sometimes they're starting to grab food out of your hand before 6 months," says BDA spokeswoman Tanya Thomas.

We will know more later this year, when the results from a large trial addressing this question will be published. In the meantime, perhaps new parents need to know about the questions hanging over the 6-month rule. They're not babies, after all. ■



STEPHEN AMBROSE/ALAMY

Mmm, this beats milk

Crystal hints at life on hellish early Earth

SOME like it hot. Carbon with an organic-like signature has been discovered sealed within a crystal that formed 4.1 billion years ago, during a period of Earth's history named after Hades, the mythological Greek god of the underworld. The crystal, from a time when Earth was still molten and firey, predates previously found evidence of life by 300 million years.

Our planet formed about 4.5 billion years ago, but it's anyone's guess when life appeared. The oldest reliable fossils are about 3.43 billion years old. Chemical signatures in older rocks suggest life might have been present 3.8 billion years ago.

Now, Elizabeth Bell and Mark Harrison at the University of California, Los Angeles, have analysed more than 10,000 zircon crystals smaller than a millimetre in length. In one Hadean crystal they found tiny flecks of graphite, which must have been incorporated when the crystal formed some 4.1 billion years ago.

Two of these graphite flecks contained the isotope of carbon known as carbon-12, a characteristic feature of organic origins (*PNAS*, doi.org/8jk).

The chemical make-up of the zircon crystals suggests that the magma they cooled from was generated by the melting of a mud-rich sediment, which is the sort of environment in which organic remains might accumulate. But there are also inorganic ways that carbon-12 could have accumulated there.

"The find from 4.1 billion years ago predates previous evidence of life by 300 million years"

Ultimately, carbon isotope data on its own is too ambiguous to decide whether Hadean carbon is evidence of life, says Thomas McCollom at the University of Colorado, Boulder (UCB).

Even so, Steve Mojzsis, also at UCB, thinks the study is important. "Harrison and his team have challenged us now to think deeply about just how ancient the biosphere could be and to find new ways to explore a cryptic record of it," Mojzsis says. Colin Barras ■



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Leafy trees slurp up the streams

Lusher carbon-fed Earth is drying out

Michael Slezak

THE carbon dioxide we've been pumping into the atmosphere is fertilising plants, making them grow faster – but now those plants are sucking our streams dry.

Australia is already parched and will only become dryer as the planet warms and rainfall decreases. On top of this, the country has lost about a quarter of its streamflow over the past 30 years, as plants given an extra boost by our carbon emissions are growing faster and slurping more water.

A similar effect could be anticipated in other semi-arid subtropical regions in the Mediterranean, southern Africa and the Americas, where rainfall is also expected to decline as global temperatures increase.

Global greening is happening for a number of reasons. Most obviously, plants are able to grow in places that were previously too cold, for example, in the Arctic, which is warming faster than anywhere else. But extra CO_2 is fertilising plants elsewhere, making them grow faster, especially in dry regions.

How that extra growth would affect water uptake has not been clear. That's because the extra CO_2 has two opposing effects, says Anna Ukkola at Macquarie University in Sydney, Australia.

Plants have a waxy seal over their leaves that stops them losing too much water to the air. To get access to the CO_2 they need to photosynthesise, plants must open little pores in that seal. But as the CO_2 goes in, water moves out.

Since there is a lot more carbon in the air than there used to be, plants can partially close their pores and still get the same amount of CO_2 while retaining more water, says Ukkola. So early models concluded that if plants lose less water, then there should be more of it in the streams, so streamflow should increase.

But later models disagreed, showing that it depends on exactly how the plants' growth is affected: if they become more leafy, then they will lose more water to the air.

"Australia has lost about a quarter of its streamflow over the past 30 years due to CO_2-fuelled greening"

Researchers have tried to sort this out by growing test plots. "But in the experiments, the changes in water use is varied – it's all over the shop," says Randal Donohue from the government's research facility, the CSIRO, in Canberra, Australia. Donohue's team was the first to show in 2013 that increased carbon levels were boosting plant cover around the world, by examining satellite images and removing the effects of other factors such as changes in rainfall and land use.

Using remote sensing data, Ukkola and colleagues have now repeated that analysis for Australia, and then compared the carbon-driven greening in 190 river basins with the changes in streamflow over that time. They found that greening of the landscape was associated with a significant drop in streamflow. In areas where the greening was greater, streamflow was also diminishing more (*Nature Climate Change*, doi.org/8jd).

Overall, the CO_2-induced greening reduced streamflow between 24 and 28 per cent, says Ukkola. "That's quite worrying for areas that are already water-scarce around Australia," she says.

This paper shows that the increase in leafiness is more significant than the efficiency gain, says Andy Pitman at the University of New South Wales in Sydney. "Nobody has been able to do that before." The plants are growing more and bigger leaves, he says, which evaporate even more water.

Ukkola says the results can probably be extrapolated to areas with similar climates to Australia like the Mediterranean. But to extend the conclusions to other places, the study would need to be repeated. That could be tricky, since you need to find river basins where land use hasn't changed significantly – an easier task in relatively sparsely populated Australia, Ukkola says.

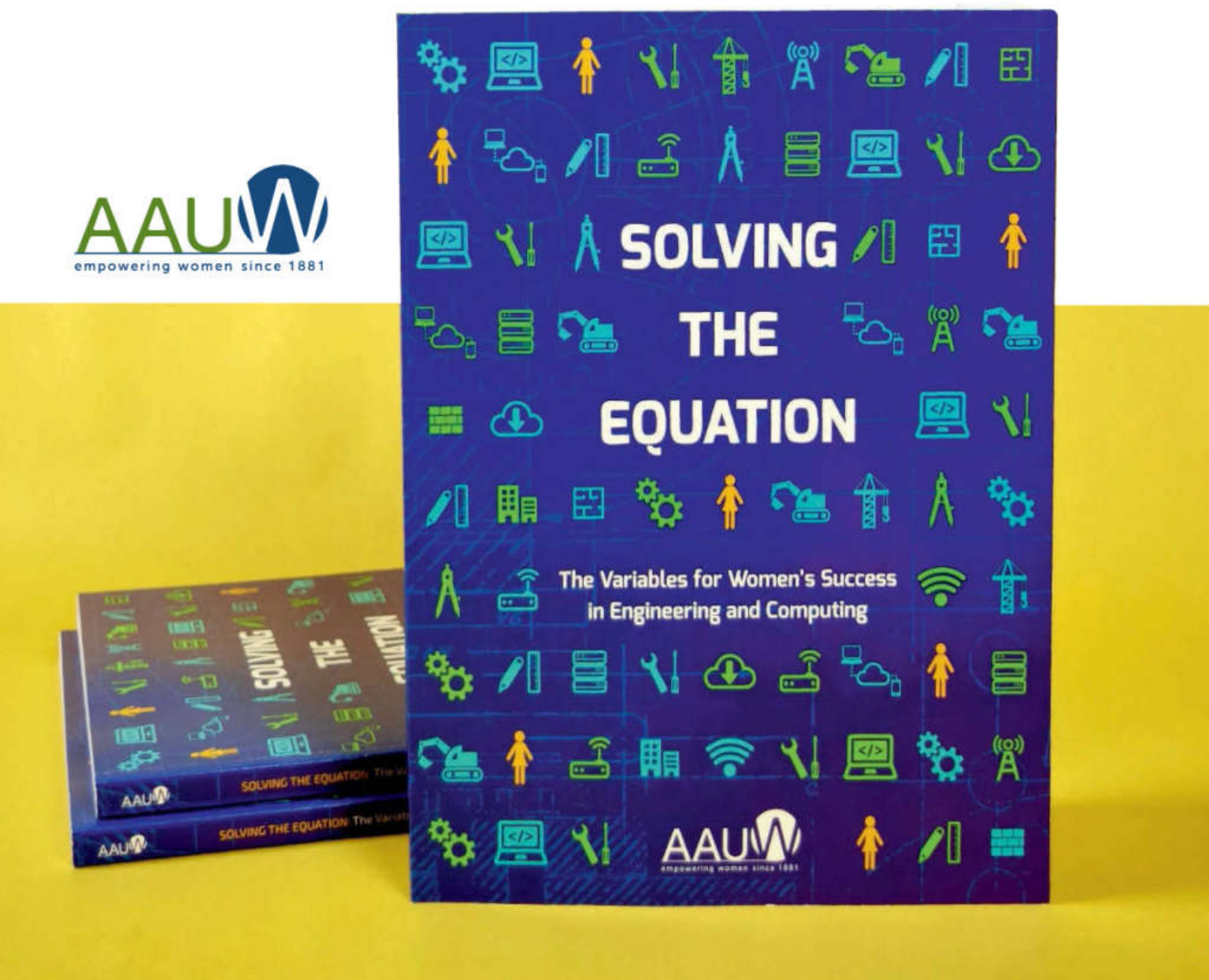
It's unclear what will happen in the future, since plants might get saturated with CO_2 at some point, and stop benefiting from even higher levels, says Ukkola. "But it's worrying that precipitation is projected to decline in Australia anyway," she says. ■

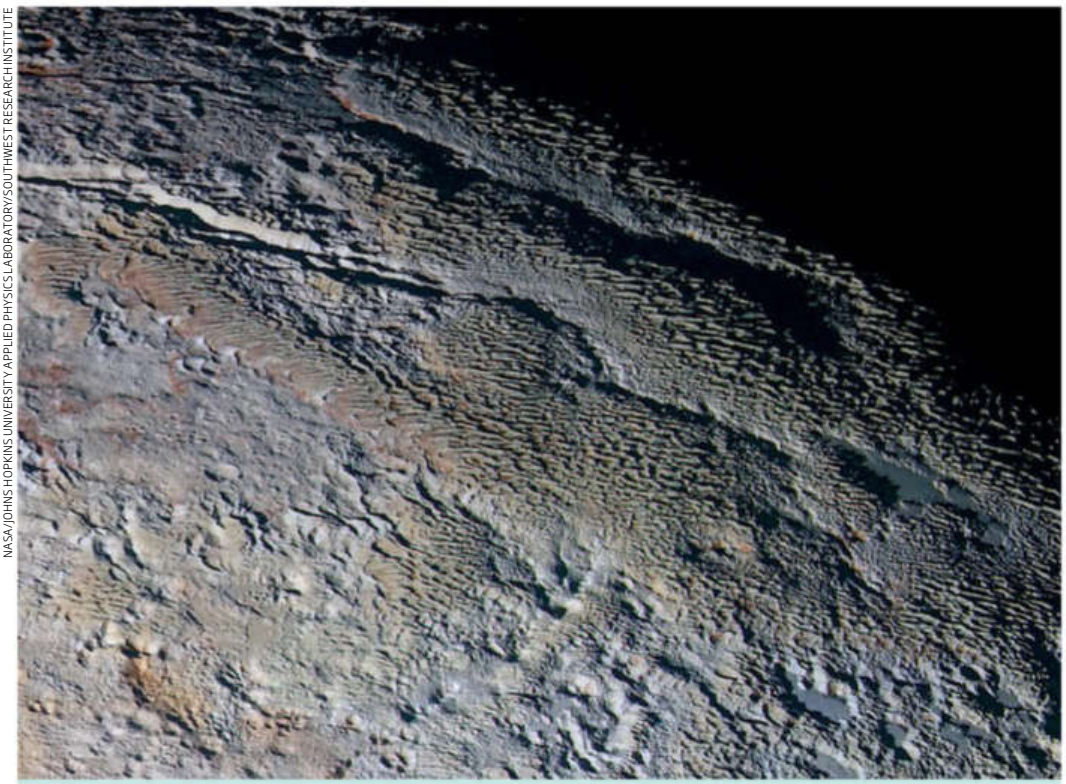
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What is responsible for Pluto's weird features?

PLUTO has emerged as the Frankenstein's monster of the outer solar system, with the terrain of many worlds thrown together into a jumbled whole. Three months after the New Horizons spacecraft visited Pluto, as the first results are officially published, there are still more questions than answers about the distant world.

Parts of Pluto's surface have almost no craters, meaning they are no more than a few hundred million years old. The dwarf planet also has 3-kilometre-high mountains made of ice, which must have been built recently. These features together imply that Pluto is geologically active – perhaps because Pluto has somehow warded off the cold better than we thought, leaving it with enough internal heat to drive geological processes (*Science*, doi.org/8b4).

Then there's the reddish tholins – hydrocarbons made in Pluto's upper atmosphere when ultraviolet sunlight splits methane molecules. For some reason they accumulate on certain areas of Pluto's surface but not others. A closer look through the atmosphere should help us match weather systems with surface features.

A lot of the data that could solve these and other mysteries is still on the New Horizons spacecraft. The team expects to download all of it by the end of next year – and we'll go from simply describing Pluto's weirdness to understanding how it emerged. Stay tuned.

There are two ways to pop balloons

IT'S a new play on snap, crackle, pop. A study of the way balloons burst has shown that they either snap open cleanly or become riddled with cracks and shatter, depending on the stress they experience beforehand. The find could help develop materials that break safely.

Mokhtar Adda-Bedia and Sébastien Moulinet of Paris Diderot University in France pumped air into latex sheets clamped over a hole. The sheets expanded, creating a balloon, until they were pierced by a blade.

By studying videos of the latex popping the pair found that it is governed by the stress of the material – the tension divided by the thickness. When the stress is low, the balloon develops a single crack that spreads from the point of the blade. But when the stress reaches a critical value, the initial crack turns into multiple cracks, fragmenting the balloon.

The pair believe that this happens because at critical stress, the material doesn't have time to reconfigure to allow a single crack to continue propagating.

They now want to apply their theory to materials like glass or metals. Tweaking these could make them less likely to dangerously fragment (*Physical Review Letters*, in press).

Flowers know how to get bees buzzing

SO THAT'S why bees are always so busy. Some flowers produce caffeinated nectar, and bees that get hooked are more active – but also potentially less productive.

Margaret Couvillon at the University of Sussex, UK, studied whether bees given sugar water containing caffeine at levels like those in nectar would come back for more. After 3 hours, the sugar water supply ran dry, but the bees kept returning in search of caffeine. "They were kind of desperate," Couvillon says.

The team found that caffeine warps other foraging behaviours: bees pumped up on it performed more enthusiastic waggle dances, encouraging more of the colony to head to the caffeinated nectar source. This could lower honey production, as plants could produce less nectar but still manage to attract bees (*Current Biology*, DOI: 10.1016/j.cub.2015.08.052).

Supersonic dino tail cracks like a whip

CRACK! A dinosaur enthusiast has recreated a sound he thinks was last heard 66 million years ago.

Some 25 years ago a researcher suggested that long-necked sauropod dinosaurs used their similarly long tails like whips, cracking the tip at supersonic speeds for communication.

Former Microsoft technology chief Nathan Myhrvold is so taken by the idea that he has built a 3.5-metre-long replica sauropod tail. He showed how it cracked like a whip at the Society of Vertebrate Paleontology in Dallas last week.

But not everyone is convinced. Cracking the tail would damage the tissue, preventing further cracking, says Ken Carpenter of the Utah State University Eastern Prehistoric Museum.

Tickled babies are difficult to trick

MR TICKLE can't bamboozle a baby. Unlike grown-ups, young infants don't let the positioning of their bodies confuse their sense of touch.

If a sighted adult with crossed legs is tickled on one foot, they can find it hard to name which one. Adults blind from birth don't have this difficulty.

"That suggests that early on in life, something to do with visual experience is crucial in setting up a typical way of perceiving touch in the external world," says Andrew Bremner at Goldsmiths, University of London.

To investigate how this develops in infancy, Bremner and his colleagues compared how babies reacted to having one foot tickled.

With their legs crossed over, babies aged 6 months moved the foot being tickled half of the time. But 4-month-olds did better, moving the tickled foot 70 per cent of the time – as often as they did with their legs uncrossed (*Current Biology*, DOI: 10.1016/j.cub.2015.08.055).

The team concludes that at 4 months, babies haven't yet learned to relate tactile stimuli to the physical space their body occupies. "It's almost like you have multiple sensory worlds: a visual world, an auditory world and a tactile world, which are separate and not combined in space," Bremner says.



RUSLANDASHINSKY/GETTY

Schizophrenia linked to brain inflammation

COULD brain inflammation be triggering schizophrenia? People with the disorder seem to have more active immune cells inside their brains. Now this activity has been spotted even before the disorder develops.

The idea that the immune system might play a part in schizophrenia was first suggested 10 years ago, and we have since learned that people with schizophrenia seem to have more active microglia – immune cells of the brain.

Peter Bloomfield at Imperial College London wondered if this immune system activity might be detectable before a person was diagnosed with schizophrenia.

His team examined 14 people who had been identified as being at "ultra-high risk" of developing the disorder.

Scans revealed that microglial activity was higher both in people at high risk and in those already diagnosed with schizophrenia than in healthy volunteers, and that increased activity correlated with worse symptoms.

During the study, two of the 14 people at ultra-high risk went on to develop schizophrenia or schizotypal disorder. These people also had the highest levels of microglial activity, says Bloomfield (*American Journal of Psychiatry*, doi.org/8b8).

If the findings can be replicated in larger studies, it might be possible for doctors to identify which people will later develop schizophrenia, and to develop preventative treatments, he says.

"This is potentially a game-changer," says Peter Uhlhaas at the University of Glasgow, UK.

3D-printed teeth fight tooth decay

LOST a tooth? Soon your dentist could print you another one – and it will help to keep your mouth healthy, too.

The advent of digital scanning and 3D printing has made fitting a false tooth simpler than it once was.

Now Andreas Herrmann of the University of Groningen in the Netherlands and his colleagues have developed an antimicrobial plastic, so they can 3D print teeth that also kill bacteria. The team embedded quaternary ammonium salts in existing dental resin polymers. The salts are positively charged and so disrupt the negatively charged bacterial membranes, causing the microbes to burst and die.

"The material can kill bacteria on contact, but it's not harmful to human cells," says Hermann.

The team put this mix in a 3D printer, hardened it with ultraviolet light and printed out false teeth.

The teeth killed over 99 per cent of decay-causing bacteria they were exposed to, compared with less than 1 per cent for a control sample without the added salts (*Advanced Functional Materials*, doi.org/f3gjhs).



TUI DE ROY/ROVING TORTOISE PHOTOS/MINDEN PICTURES

Galapagos gains a new giant tortoise

TORTOISES on the Galapagos now number 11 species, thanks to a fresh addition from the central island of Santa Cruz.

For more than a century, taxonomists thought that the island had only a single species of giant tortoise. But in 2005, a genetic analysis hinted that there might be more. A decade-long study has now led researchers to conclude that the island actually hosts two species.

The two species inhabit parts of Santa Cruz just 20 kilometres apart, but they are as genetically different from each other as any other tortoises in the archipelago, says Adalgisa Caccone, a geneticist at Yale University.

One species lives at La Reserva on the south-western slopes of Santa Cruz, and retains the original name given to the Santa Cruz tortoises, *Chelonoidis porteri*.

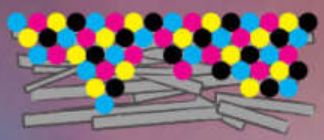
The second inhabits the much drier eastern slopes at a site known as Cerro Fatal, and will go by the name of *Chelonoidis donfaustoi*, in tribute to the veteran Galapagos National Park ranger Fausto Llerena (*PLoS One*, DOI: 10.1371/journal.pone.0138779).

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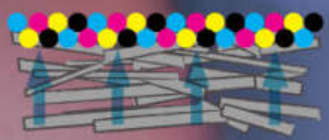
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Tracking the health of 10,000 New Yorkers

Last week brought us inside China's data-driven system for scoring its citizens. In this second instalment of our two-part data special **Aviva Rutkin** looks at a scheme to uncover medical secrets in the numbers of everyday life



MATTHEW PILLSBURY, COURTESY BENRUBI GALLERY

THERE is life in data, if you know how where to look: the number of steps from your apartment to the coffee shop, the cost of a latte, the levels of pollution in the October air you're breathing in. As we move through the world, we leave thousands of other signals behind us that speak volumes about our health and well-being. Now, a new project in New York City will gather and process those signals on an unprecedented scale.

The ambitious scheme, named the Kavli HUMAN Project, will track every last scrap of data generated by 10,000 New Yorkers. Taken together, that data will weave a detailed narrative of each person's life – where they go, what they do, how they're feeling, how they walk the line between sickness and health.

The idea is to dive deep into everyday situations, says Dennis Ausiello, director of the Center for Assessment Technology and Continuous Health in Boston, who is advising the HUMAN team. The medical community is good at diagnosing disease, but struggles to understand what it means for people to be in good health. When it comes to our health, he says, it doesn't make sense to wait until something is wrong to start paying attention.

Instead, we can learn what good health looks like and how to maintain it by tuning in to the fluctuating rhythms of life – diet, exercise, sleep, medication. "Medicine works by you setting a date on the calendar for a doctor's visit," Ausiello says. "Real life works 24/7."

HUMAN plans to start recruiting in early 2017. A randomly selected group of New Yorkers will be asked to hand over their personal data for the next 20 years. Among the long list of things the scientists hope to track, outlined in a paper published earlier this month (*Big Data*, doi.org/8bt) are: electronic medical records; credit card transactions and banking documents; school and employment history. Then there are emergency calls, arrests or other interactions with law enforcement, as well as location, as captured by a smartphone's GPS tracker.

Beyond that, there's a wealth of environmental data to consider, like city records on the building the person lives in, demographic details about the neighbourhood, and environmental measurements such as air quality and noise levels.

And that's just the stuff that's already out there. The researchers plan for participants to undergo an extensive physical examination, including microbiome samples; genetic tests; and interviews with psychological professionals. Mental status will be regularly assessed through voluntary surveys, pushed to a smartphone. Participants may also be asked to don a wearable device, like a Fitbit, to capture their physical activity, or a silicone wristband to track their chemical exposure. Bluetooth sensors placed around the home could quietly collect information on activity and family interactions.

What will this truckload of data turn up? It's hard to say, says Steve Koonin, director of the Center for Urban Science and Progress at New York University. That is what makes it so exciting.

"What did Galileo think he was going to see when he turned his telescope on the heavens? He didn't know," he says. "This notion of discovery is very powerful for me."

Studies that take the long view are not new. For example, the Framingham Heart Study, running since 1948, has discovered many risk factors for cardiovascular disease by following three generations of adults in Massachusetts. In the UK, the English Longitudinal Study on Ageing has followed the changing health, lifestyle and economic well-being of older adults since 2002. But while these studies check up on people once every few months using traditional doctor's tools like CT scans, HUMAN will be able

AN APPLE A DAY

On Thursday, Apple announced that its ResearchKit software would now be used in studies of autism, epilepsy and melanoma. Working together with university researchers, Apple will gather yet more data through its smartphone and watch, then turn that new lens on disease. Apple has already amassed medical data on a huge scale. "ResearchKit apps are already providing insights to scientists around the world and more than 100,000 participants are choosing to contribute their data," Apple's Jeff Williams said in a statement. Dennis Ausiello's team at the Center for Assessment Technology and Continuous Health in Boston (see main story) has been working with ResearchKit too. Their app, GlucoSuccess, lets diabetic people track their blood sugar level, diet and exercise. Ausiello says diabetes is probably a whole family of diseases that we have difficulty pulling apart diagnostically. Detailed records on many individuals with diabetes may provide greater insights.



Life logging: good health dissected

to track every minute or second, polling data from the genome to the commute. Smartphones – now in almost every pocket in the rich world – are a driving force behind this new way to study human health. They act as both sensors and filing cabinets, allowing physicians to gather real-life health data.

One slow-moving mystery HUMAN hopes to tackle is obesity, a growing issue in the US. Without detailed information, it's difficult to unpick the mesh of biological, psychological, and economic factors that might push us to eat too much cheap, processed food that's high in fat and sugar. Credit card records and location data could help establish what kind of food a participant eats, while information about their genetic make-up or demographic surroundings might suggest additional pressures.

The project will also study cognitive decline. Sixteen million people in the US suffer from some form of cognitive impairment, such as Alzheimer's disease or dementia, according to the Centers for Disease Control. Studies provide some insight into who might be at risk – those who retire later in life seem less likely to develop dementia, for example – but there are probably other behavioural or environmental factors that have yet to be sussed out.

"A randomly selected group of New Yorkers will hand over their personal data for the next 20 years"

"We've come to understand that it's an entire life history that gives rise to the various wounds and bruises that make for all types of mental decline," says the director of HUMAN's scientific agenda, Andrew Caplin, "but how this is unfolding, we really don't know."

The HUMAN project is a massive undertaking – and one that may be tricky to get right. As the design of the study is being finalised, a panel is exploring how best to protect everyone's data. One crucial step, says Koonin, will be to ensure that participants understand what it is that they're signing up for. Encrypting the data and restricting researchers from accessing the entire set at once could also help maintain privacy.

But with such detailed data sets it may be difficult or even impossible to maintain files that can't be traced back to individuals. A study published in January of this year, for example, found that people could be identified in 1.1 million "anonymised" credit card records using just four clues to what they'd purchased or where they'd been. Another experiment from the same lab did a similar trick with cellphone location records, recognising about 95 per cent of users.

Samuel Volchenboum, director of the University of Chicago's Center for Research Informatics, sees the potential benefits of the project, but worries that it may get tripped up by data collection long before it's time to crunch the numbers. Most studies, he says, still struggle to combine disparate and mismatched data sources, or to get patients to keep up with a single new device or app.

Caplin compares this new way of studying health to the famous documentary series *Up*. The films followed the lives of a group of British children, checking in with them every seven years.

"You watch that and say, how on earth can people change this way?" says Caplin. "Every one of us goes through a story that, if you had been tracking it in its richness, would have had its own logic." HUMAN will attempt to capture that richness, logging snapshots almost continuously of everything from DNA to travel patterns, to understand how and why humans change. ■

A WORLD OF DATA

The Kavli HUMAN Project will collect a huge range of data. Here's where it will come from, and what it will say about the volunteers

HOME

City records on your building and neighbourhood show what kind of environment you live in, while sensors placed outside measure air quality and ambient noise.

SMARTPHONE

Smartphones can use GPS, Wi-Fi and cellular networks to track where you go. Tests pushed directly to your phone can indicate your cognitive or mental state. Real-time data from the phone lets researchers track your behaviour and catch changes as they happen.

SPENDING

Credit and debit card records show where you buy food and what you're eating, revealing your diet. Purchase data can also indicate when you pick up cigarettes, alcohol or prescription drugs.

EXERCISE

A wearable or smartwatch can keep tabs on your activity, measuring how much exercise you're getting.

MEDICAL

Stool and saliva samples reveal the bacteria in your microbiome, while blood tests reveal your genetics. Electronic records hold your medical and dental history.

PUBLIC RECORDS

School, court and government records indicate your social and economic status. The police department and district attorney maintain records of 911 calls, arrests and other run-ins with the law.

To trust a robot

Aviva Rutkin finds out why robots don't inspire confidence

SOMEONE was arguing with the robot again.

At the Institute for Intelligent Systems and Robotics in Paris, France, 56 adults had been invited to spend time with iCub, a humanoid research robot. The goal: to understand how much humans trust robots.

It's an important question as more and more robots enter the workplace, says lead researcher Serena Ivaldi. If they are to work together successfully, humans need to be sure of their machine colleagues.

"We want to test if people are ready to have confidence and trust in a robot," says Ivaldi, now at the French Institute for Research in Computer Science and Automation (INRIA). "We're specifically interested in knowing what they expect that's not what we, as roboticists, would think of. What do we need to do to make robots suitable for them?"

Ivaldi's team first put questions to the human participants. Some were straightforward: "Which of these two sounds is more high-pitched?" or "Which of these objects is heaviest?" Others were more nuanced, asking the person which of two objects might be better to pack for the beach or a rainy day, for example.

Then the robot got a chance to answer. Its choice, controlled behind the scenes by another researcher, was always contrary to what the human had said. After hearing the robot's response, the volunteer was asked: do you want to change your answer?

Most of the time, people stuck with their initial response. To Ivaldi's surprise, some started talking to the robot as if it were a person, trying to convince it to take their side.

Some people, however, did change their answers after hearing the robot's response. Thirteen of them tended to go with its choices on the measurement questions. But only three were convinced by its responses to the ambiguous social questions, indicating that robots are still far from being seen as an authority (arxiv.org/abs/1510.03678).

"Some people talked to the robot as if it were human, trying to convince it to take their side"

People behave differently around autonomous robots than they do around computers or other machines, perhaps because they know that robots possess a level of intelligence, says Aaron Steinfeld at Carnegie Mellon University in Pittsburgh, Pennsylvania.

A way to make robots easier to trust would be to design them so that their functionality is more obvious, and people will then have a better sense of what kinds of tasks to trust them with, says Ivaldi. In complicated or stressful situations, having this sort of information might be important, particularly if a robot can do the job better than a human.

Steinfeld has explored how people act when controlling a robot in a search-and-rescue task. They were more likely to trust it – leaving it in autonomous mode rather than switching to manual – when they saw the robot perform well. "A robot that's reliable will lead to more trust, which is actually as it should be," he says. ■



RYERSON/POLARIS/EYEVINE

Let me help you

ONE PER CENT



Uber wins legal fight

Drive on, Uber. The UK high court has ruled that the taxi-booking firm is legal in London, after it won a case brought by regulator Transport for London (TfL). Black cab drivers in the city had called for TfL to challenge Uber because only they are authorised to use a meter. Uber works out fares using the GPS signal from a driver's phone. As this calculation takes place on a server outside the vehicle, the court ruled that the firm's app wasn't a meter.

4.6m

The number of people in the US who have updated their Facebook profile to express an attraction to the same sex or chosen a custom gender since 2012

See more smartphone

Smartphone cameras may soon be able to photograph a hidden world. An imaging technique developed by Shwetak Patel and his team at the University of Washington goes beyond the visible spectrum to the near-infrared, letting cameras see the veins in a human hand or the ripeness of a piece of fruit, for example. It could be made to fit inside a smartphone, says Patel, and was presented at the Ubicomp conference in Osaka, Japan, last month.

FOCUS TECHNOLOGY / ALAMY STOCK PHOTO

DEVELOP National Program



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For more information on how you can join the DEVELOP team visit **http://develop.larc.nasa.gov**





Tunnel vision

THIS is not the typical view of the Sierra Nevada mountains in southern Spain. As the snow covering the peaks (the name means "snowy range") retreats in spring, it melts from above and below, forming a honeycomb of tunnels. The thinning blanket of snow acts as a greenhouse, letting light through and reviving grass that has been slumped since the start of autumn.

Photographer Ugo Mellone had heard about the tunnels and ventured into the mountains to document them. This image made the finals in the Land category at the recent Wildlife Photographer of the Year awards in London.

Getting the shot wasn't easy. For one thing, the tunnels only last a short while before melting. For another, they lie around 2600 metres above sea level. "I like that I took this picture in a very wild and remote place, and that I toiled a lot to get it," says Mellone. "I like the sense of mystery it inspires, and that it shows a process: the snow melting into the stream, which also makes possible the growing of the plants on the shore."

Much of the landscape in the Sierra Nevada is barren, so the streamside meadows are home to a lot of endemic plants. "I hope to raise curiosity about what kind of environments can host such unusual tunnels, about what there is at the end of the tunnel," Mellone says. Rowan Hooper

Photographer
Ugo Mellone wildphoto.it

A gap too far

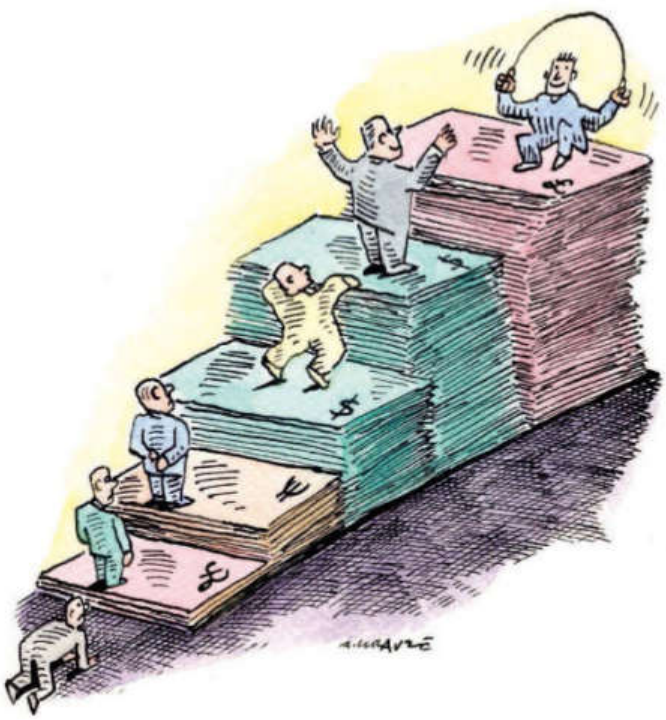
Globally, people are dying from preventable health inequalities. It's a complex problem to fix, says **Michael Marmot**, but we must do it

IMAGINE the outrage if a newspaper ran a story stating that a million people in the UK had died from a treatable medical condition over the past five years. Health ministers would be interrogated, government enquiries promised – and the public would be left with a terrible feeling of unease.

But those people really did die, and from a preventable condition: health inequality. The scary but real figure came from *Fair Society, Healthy Lives*, the 2010 report I produced when asked by the UK government to review health inequalities, and was repeated in *The Health Gap*, my latest book. I calculated that if everyone in England over 30 had the same low mortality rate as university-educated people, there would be 202,000 fewer deaths each year – almost half the current total.

This pattern of lost years is a global phenomenon. Last month, the US National Academy of Sciences reported that at the age of 50, life expectancy for a man in the US in the poorest 20 per cent of the population had declined slightly in the last 30 years to 26.1 years. By contrast, life expectancy in the richest 20 per cent had improved by 7.1 years to 38.8 years – a difference of 12.7 years.

So the problem of health inequalities endures or is getting worse. Is anyone listening? Do we know how to reduce those inequalities? Are we doing it? The answer to all three questions is yes, but with major qualifications: the problem and the solution are complex, and are reflected very differently in different countries.



In the UK, at least, people are listening. Health minister Jeremy Hunt recently cited my book as showing an 18-year gap in male life expectancy between the richest and poorest in the London borough of Westminster – one of the richest spots on the planet. He added we should be ashamed, a clear indication he agrees that we should be able to do something about it.

Listening isn't doing, of course, but it is a good first step. There is a great deal of listening going on in Latin America, India, the eastern Mediterranean and the European region of the World Health Organization. This shows up in the resolutions of the WHO's World Health Assembly.

Those who do listen are beginning to see the complexity of the issues. We no longer have to deal with 19th-century squalor and its consequences, but there are new ways of doing without and new pressures that are just as devastating. The health gap didn't widen in the past 30 years in the US and UK for lack of indoor toilets, but because people are not able to live lives that they value.

Such disempowerment arises from adverse social and psycho-social conditions. A causal thread links health inequalities to life conditions, from the quality of input surrounding early child development, through inequalities in education, employment and working milieu, to the conditions for older people.

"We should all be calling for action across society because we all are affected by health inequalities"

There is evidence, though, that improvements at any stage of life can make a difference. Action at community and whole society level is important. Take British Columbia, with a shockingly high suicide rate in young aboriginal Canadians. Communities within the province with control over their own services have avoided this epidemic. And at country level, health inequalities in Brazil have fallen from a very high level, due in part to schemes where poor families receive cash subsidies for meeting conditions such as taking their children to nutrition clinics. This may explain why inequalities in the growth of young children have been sharply reduced.

That leads to my third question: why aren't governments taking the actions we know improve health and reduce health inequalities? Ever the optimist, I would say that some countries are, but that not one is doing enough. The problem is that to act on the social determinants of health, they must get past the assumption that inequalities in health arise from inequalities in healthcare.

In the UK, with universal access, healthcare isn't the issue. Having discovered prevention, the reflex of health authorities is to focus on educating us to behave better. But we have known for a long time

that this doesn't work: it ignores the reasons why people have poor diets, drink too much, smoke and are physically inactive – in other words, the causes of the causes.

There is a much bigger conceptual problem: health inequalities aren't confined to poor health for the poor and good health for everyone else. There is a gradient in health running from top to bottom of the social hierarchy. We should all be calling for action across the whole of society because we are all affected by inequalities in health.

But governments have other priorities. Austerity has caught on like an epidemic, flying in the face of mainstream economists' views that it damages economic growth. And there is plenty of evidence that health is damaged by austerity: take Greece, where rising suicide is the most dramatic example. More generally, Will Hutton, head of Big Innovation Centre, sees the UK as "becoming the laboratory for a libertarian, anti-social justice experiment" based on neo-liberal economics. Unchecked, I believe that these will increase health inequalities.

As president of the World Medical Association for the coming year, I have signalled that my themes will be social justice and health, and health equity. There is a well of enthusiasm from doctors to make a difference to the social environment in which their patients are born, grow, live, work and age. But enthusiasm from government, backed by an informed public, is also essential.

As I say at the end of my book, if you live in a country with poorly developed social systems, do something because it will make a difference. If your country has started to make improvements, do more. And if you live in one of the Nordic countries, do it better. ■

Michael Marmot also directs the UCL Institute of Health Equity and is Lown Professor at Harvard University. His book, *The Health Gap*, is published by Bloomsbury

ONE MINUTE INTERVIEW

Australian rice to the rescue

Climate change and disease threaten Asia's staple crop, but Australia's wild rice could save it, says **Robert Henry**



PROFILE

Robert Henry directs the Queensland Alliance for Agriculture and Food Innovation at the University of Queensland, Australia. He studies the genomes of crops and their wild relatives to help diversify and adapt agriculture

Why are you investigating the wild relatives of domesticated rice?

The wild varieties are closely related to domesticated rice, and the samples we collect will provide an invaluable source of tolerance to a range of environmental stresses, from drought to salt to heat. These traits will be important in producing climate-resilient crops for the future.

Why search in Australia rather than Asia?

In Asia, rice has been farmed for 7000 years or more, and wild populations have been overwhelmed by interbreeding with domesticated rice. The wild populations in Australia's remote areas are not genetically polluted by agriculture, so I recently led an expedition to the tropical Cape York Peninsula in northern Australia.

One disease, rice blast, is currently damaging plants in Asia. Some of our Australian populations have been exposed to this fungus for thousands of years in the wild, and we expect that they have developed a certain natural resistance to it that we can capture for agriculture.

Where were these plants growing?

The rice grows in water up to a metre deep. We had to be especially cautious entering the lagoons, waterholes, lakes and swamps that contain the rice because they're also the habitat of saltwater crocodiles.

In breeding new rice varieties, will crop scientists be using genetic modification?

There's no need. By using advanced DNA-analysis tools we can determine which individuals have inherited the genes that we are interested in and they can be cross-bred with modern varieties. DNA sequencing is advancing so fast. Our capabilities actually double every six months or so – it's extraordinary. We're scrambling to apply these advances to agriculture around the world.

What do you think of keeping banks of seeds to insure against wild plants dying out?

Collecting material and putting it into seed banks is good, but we effectively stop evolution when we do that. By keeping the plants in the wild, they will continue to evolve with climate change. That's why it is vital to preserve ecosystems. We're allowing natural selection to take us in some of the directions we need to go as the climate shifts.

Can the wild varieties you are collecting be used to improve the nutrition of rice?

Farmers tend to grow rice that cooks more quickly. In fact, we would probably be better off eating rice that might take a little longer to cook, that has a lower glycaemic index and so is less likely to induce diabetes and contribute to obesity. There's variation in the wild that could enhance rice from a health perspective.

What keeps you excited about your work?

In wheat, we've recently discovered genes that control bread quality, how much the bread rises and how much flour we'll get out of the grain. We've found the gene for fragrance in rice – so important in basmati rice. We've even identified genes controlling how long it takes to cook.

Interview by Richard Schiffman

QAAFI

What are the icons of the prolific present?

The present is awash with the flotsam of consumerism. Should we keep it all as a record of our times? If not, what do we save, asks **Sharon MacDonald**



Tell me about the Heritage Futures programme that you are involved with.
It is based around the idea that the things that will be heritage in the future are being made right now. My focus as a cultural anthropologist is on what's going to be around later to get defined as the cultural history of the West. How are we creating and curating the archive of the future?

One big challenge is to know what to save when there are so many things from which to choose. I think we urgently need get a handle on what is sometimes called post-scarcity culture, but which I prefer to call the prolific present.

Why is this "prolific present" such a problem?
Mass production and consumption has generated a runaway train effect, which threatens to one day overwhelm us. People in Western countries now typically own more than 2000 objects each. This explosion of consumer goods, and virtually limitless potential for digital storage, is creating big dilemmas over what to save for the future, and how we go about it. I'm interested at the household level and also in museums that collect from the recent past and from today – especially social history museums, which have to deal with this profusion.

Why are we so obsessed with material objects that are not essential for our day-to-day lives?
This is a deep issue about how people form identities. A modern way in which we set ourselves apart and express who we are is with our choices about what we buy and what these objects say about us.

Do all these possessions make us happier?
It's extraordinary, if you search "declutter" online, there's so much advice about how to get rid of stuff. And often it's quite moralised: there's this idea that you can improve yourself by getting rid of things, that you can rescue yourself from a sort of morass. But we find it hard to let go of things. For example, the number of self-storage units has really taken off in the UK this century, though the US is in a league of its own – 1 in 10 households there buy additional storage. Are they just putting this extra stuff out of sight so they don't have to make a decision?

It can feel hard to throw things out…
Absolutely, and at the extreme there's the complete inability to dispose of stuff, revealed by a whole load of television programmes dedicated to so-called "extreme hoarders". We're fascinated by such people because we think, "Ah, that's what I might become if I'm not careful". It makes us question who are we and where we want to be on this spectrum. It's a sign of the prolific present that in 2013 hoarding became a distinct, medicalised disorder in the US psychiatry diagnostic manual, *DSM-5*.

How is the prolific present affecting museums?
Museums that deal with social history are having huge problems. They face this question: do we need an example of all the different cups or laptops that come out, or can we just take one brand and one model. How do we choose? York Castle Museum is a case in point. Its social history collections contain about 30,000 items, and it had to temporarily halt collecting in order to review its policy.

Many museums are swamped with a backlog of uncatalogued stuff. This problem has been exacerbated by the increasing "democratisation of the past" – the idea that museums should try to represent as many levels of society as possible. But where do we draw the line? If museums stop collecting, as some are now doing because of costs and because they have run out of storage space,

PROFILE
Sharon MacDonald is Alexander von Humboldt Professor of social anthropology at the Humboldt University of Berlin, Germany. She leads the Curating Profusion project, part of the Heritage Futures programme, at the University of York, UK

Photographed for New Scientist by Kai Muller



they may turn into museums only of the more distant past. So, despite the profusion, there will actually be less collected to represent this period of our history for the future.

How can we judge what our descendants will find important?
That's a tough question. One response is that we should try to keep everything, because we can't know in advance. Go in that direction and it's a bottomless pit. Our descendants won't have endless time to sift through everything we've kept. And we would do them a disservice if we tried to keep everything, because the decisions about what we choose to preserve say a lot about our culture. For example, if we look at excavations of ancient burial sites, what's interesting to us today is the objects that people tried to take with them into the afterlife.

What can we learn about the Ancient Egyptians from the objects they chose to keep?
In some periods in Ancient Egypt – including that of Tutankhamen – people probably saw the afterlife as quite dangerous, as they took weapons, but also as not without social opportunities because they took cosmetics and musical instruments. And that shows us too that they believed they would continue to have physical form in the next life.

What cultural differences have you seen in the objects chosen to preserve for the future?
There are cultures in which decay and even destruction are seen as important for releasing creative energy for future generations. Traditionally among Igbo people in West Africa, for example, it was regarded as necessary to let art works decay so that new ones could come into being. And in various cultures there's the idea that things associated with people who have died should be destroyed in order to ensure their spirits don't come back and haunt the present. Certain Native American groups would burn down the home of the deceased to stop their ghost from coming back.

"Our descendants won't have endless time to sift through everything we've kept"

How do we decide what's personally important?
I think that, a lot of the time, the stuff we acquire is a matter of the moment and people aren't strategising carefully about the future. But I think personal crunch points come, like when you move house, as I currently am. Suddenly, you've got to think about what really matters. The ridiculous thing I'm agonising over at the moment is a birdcage. It is a purely decorative thing that my parents owned before giving it to me. It has been in every house that we've lived in and it actually annoys me because it's large, awkward and attracts dust – but it would feel destructive to get rid of it now. I feel like it has earned its keep by having managed to hang around so long!

Is there anything you absolutely must keep?
I have an absurd number of books and yet I absolutely assume that I will keep them. I talked to one of my daughters about this. She's 22, but she took it for granted that books should be kept. In the age of digital readers, I was pleasantly surprised by that. ■

Interview by Sean O'Neill



The universe's largest objects could conceal intruders from dimensions beyond our own. **Colin Stuart** tracks them down

WHEN WORLDS COLLIDE



A GIANT hole in the web of galaxies that fills the cosmos. A colossal string of quasars billions of light years across. A ring made out of hugely energetic bursts of radiation that spans 6 per cent of the visible universe. As our observations of the cosmos come into ever sharper focus, astronomers are beginning to identify structures bigger than any seen before. There's only one problem: none of them should be there.

Ever since Copernicus proposed his revolutionary idea that Earth's place among the stars is nothing special, astronomers have regarded it as fundamental. The cosmological principle it has evolved into goes a step further, stating that nowhere in the universe is special. You're allowed to have patches of individuality on the level of solar systems, galaxies and galaxy clusters, of course, but zoom out far enough and the universe should exhibit a drab homogeneity. No vast galactic walls or bald spots, and no huge structures.

Small wonder that the spate of recent findings has got cosmologists hot under the collar. But the solution could prove equally controversial. One researcher claims these massive structures are illusions projected from another dimension, the first tantalising evidence of realities beyond our own. If he is right, and these behemoths don't exist as physical objects within our universe, then the cosmological principle might still be safe.

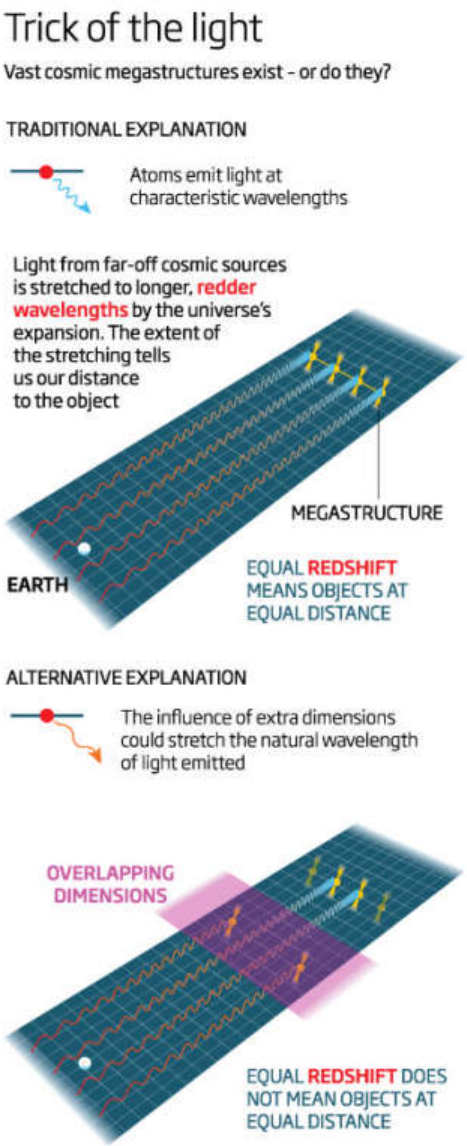
The concept of favoured regions in the universe is anathema to modern cosmology. "All our thinking since the Renaissance has been working against that idea," says Seshadri Nadathur, a cosmologist at the University of Portsmouth in the UK. It also makes using Einstein's general theory of relativity to understand gravity's role in the evolution of our universe an even more fiendish task than it already is. "Einstein's equations are much easier to solve if you assume a universe that's almost homogeneous," says Nadathur. But, at the moment, the cosmological principle is just that – an assumption. There is no concrete evidence that it is true, and the evidence we do have seems increasingly against it.

Take that giant hole in the universe – a void almost 2 billion light years wide, according to its co-discoverer, András Kovács of the Institute for High Energy Physics in Barcelona, Spain. "There are 10,000 fewer galaxies in that part of the sky compared with the universal average," says Kovács. Based on the latest data, astronomers believe that the cosmological principle must apply on scales of roughly a billion light years, with the average amount of material in any given volume more or less the same. A big empty patch almost double the size of the cut-off stands out like a sore thumb. Kovács and his team call this vast expanse a supervoid, and believe it might explain away the giant cold spot in the cosmic microwave background, an observation that has been puzzling astronomers for over a decade (see "CMB cold spot", page 33).

And the supervoid isn't the half of it. As far back as 2012, a team led by Roger Clowes at the University of Central Lancashire, UK, claimed to have found an enormous structure strung out over 4 billion light years – more than twice the size of the supervoid. "We thought 'what is that!?' It was obviously something very unusual," says Clowes. Yet this time it wasn't an empty patch of space, but a particularly ›



DOALY




ESO/M. KORNMESSER

crowded one. Known as the Huge Large Quasar Group, it contains 73 quasars – the bright, active central regions of very distant galaxies. Astronomers have known since the early 1980s that quasars tend to huddle together, but never before had a grouping been found on such a large scale.

Then earlier this year a team of Hungarian astronomers uncovered a colossal group of gamma-ray bursts (GRBs) – highly energetic, short-lived flashes of energy erupting from distant galaxies. The galaxies emitting these GRBs appear to form a ring a whopping 5.6 billion light years across – 6 per cent of the size of the entire visible universe. "We really didn't expect to find something this big," says Lajos Balázs from the Konkoly Observatory in Budapest, Hungary, who led the study. Its size makes it five times larger than the typical scale at which the cosmological principle tells us that homogeneity should kick in.

So fundamental is the cosmological principle to our understanding of the universe that such apparent violations make astronomers and cosmologists deeply uncomfortable, even those who discovered them in the first place. When it comes to the intense flashes of light that make up the GRB ring, for instance, there's a possibility they might be surrounded by other galaxies, currently shining less brightly because of an absence of GRBs. It's like being in a darkened room in which light bulbs are evenly distributed: if only a few are illuminated when you look into the room, you're likely to draw the wrong conclusions about how they are arranged. "It doesn't necessarily contradict the cosmological principle," says Balázs.

Rise of the giant-killers

The huge large quasar group is also the subject of intense debate. "I don't think it's really a structure at all," says Nadathur. In 2013, he published a paper studying the algorithm Clowes and his team used to analyse their data, calculating the probability that a random distribution of quasars would also yield an apparent structure. "The chances of seeing a pattern like the one they see, even if there is nothing there, is quite high," he says. But the giant might not be dead just yet. Clowes's PhD student, Gabriel Marinello, is working on a paper countering Nadathur's claims, which he describes as "conservative and unrealistic". He argues that instead of modelling a random distribution, Nadathur should have included the fact that quasars – just like other galaxies – are known to huddle together on scales of around 300 million light years.

As well as the quasar group, Nadathur thinks the supervoid could also be reconciled with the cosmological principle. "The principle is not saying that any one place cannot fluctuate from the norm, just that on average the large-scale universe must be homogeneous," says Nadathur. In short, the probability of finding objects like the supervoid is not zero. There just can't be too many of them.

But Rainer Dick, a theoretical physicist at the University of Saskatchewan, Canada, believes such attempts to brush these cosmic megastructures aside are misguided. In fact, he says they should be embraced as our best bet of keeping the cosmological principle alive. All we have to do is accept that they don't actually exist. Instead, they represent the first evidence of other dimensions intruding into our own, leaving dirty footprints behind on our otherwise smooth and homogeneous cosmic background.

It seems a breathtakingly audacious proposal – but it builds on a solid foundation of theoretical work. For one thing, conjuring up other dimensions beyond our own is nothing new. For decades, many theorists have regarded the existence of extra dimensions as our best hope of reconciling Einstein's general relativity with that other bastion of 20th century physics: quantum theory. A marriage between these two seemingly disparate concepts, one dealing with the very large and the other with the very small, would yield what is often called a theory of everything, a one-size-fits-all framework capable of describing the universe in its entirety.

One popular candidate is M-theory, an extension of string theory that famously suggests we live in an 11 dimensional universe, with the other seven dimensions curled up so tightly as to drop out of sight. It's an elegant and mathematically appealing framework with a number of influential supporters. But it has one major failing: the lack of solid predictions offering opportunities to verify it. Dick's work on a generalisation of string theory known as brane theory might provide just such a prediction, and resolve the cosmological principle dilemma to boot.

At the heart of brane theory is the idea that what we perceive as our universe is a single four dimensional membrane floating in a sea



Quasars emit jets of radiation that make them among the brightest objects in the universe

of similar branes spanning multiple extra dimensions. Such an idea is not inconsistent with our established theory of gravity, says Dick, as "you can add infinitely large extra dimensions and still get back general relativity".

Although the other branes occupy extra dimensions, and so would be impossible to observe directly, the theory suggests we might just be able to spot the effects of a neighbouring brane overlapping with ours.

So how does this help with the problem of the cosmological principle? Well, in order to measure our distance to far-off objects, astronomers exploit an effect known as redshift. They break down the light from the object using a spectrometer – a fancy version of a prism – to reveal bands known as spectral lines. Any object moving away from us because of the universe's ongoing expansion will have its light stretched out to longer, redder wavelengths and the lines will appear shifted towards the red end of the spectrum. The further away the object, the faster it will appear to recede and the more the lines will shift. If astronomers see many objects all exhibiting the same redshift, they will interpret that as some form of structure, just like the GRB ring or the huge quasar group.

Except, looking into a region where another brane is overlapping with our own might skew our redshift measurements. Under these conditions, photons in one brane would exert a force on charged particles in another – a phenomenon Dick calls brane crosstalk. "This would change the distance between the energy levels within hydrogen atoms in the overlap region," he says. Electrons moving between these energy levels either emit or absorb photons, producing the spectral lines we rely on for working out their distance from Earth.

But if brane crosstalk were to narrow the energy-level gap, this would produce photons of a slightly longer wavelength – a redshift that has nothing to do with the expansion of the universe. If you fail to take this into account, and assume the overall redshift you measure is solely the result of distance, then you will systematically overestimate how far away an object in the overlap region actually is, with large swathes of empty space visible in its true location (see diagram).

If such a model held true, areas of brane overlap would produce an apparent pile-up of objects at one redshift and a distinct lack of objects at another – an optical illusion that would make a homogeneous universe appear to contain massive structures and enormous voids. In a stroke, this would explain the origins of the quasar group and the GRB ring as well as the supervoid, says Dick. "These structures match the potential signal of brane crosstalk."

Of course, it's hardly an open-and-shut case. "There are many assumptions that one must accept in order for this to happen, and some of them may just be taking things a bit too far," says Moataz Emam from the State University of New York College at Cortland. Emam also warns that some of the assumptions about gravity that Dick's theory relies on have been severely criticised in the past, not least by string theorists who have had difficulty reconciling them with their calculations. "But his model is certainly testable," he says.

Emam suggests that the necessary evidence could be found by observing parts of the sky where high density regions coexist next to apparent barren patches. Provided the discrepancy in redshift measurements is identical in all cases, it might well suggest that our brane is overlapping with another.

With the help of the Sloan Digital Sky Survey (SDSS) – the most detailed three-dimensional map of the universe ever made – Dick is now planning to scour the databases for redshift data that could support his theory. "That really would be compelling evidence that our universe is not alone," he says. Such a discovery would not only explain away some of the most perplexing observations in astronomy, but give the abstract field of string theory a tantalising experimental foundation.

But his quest to cut the universe's largest objects down to size might lead to new monsters arising in their place. The discovery of branes beyond our own, for instance, would pose a serious challenge to humanity's fragile sense of its place in the cosmos, and make a nonsense of our concept of cosmic homogeneity. In a vast multiverse of interacting membranes, the cosmological principle might not be worth saving after all. ■

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"That really would be compelling evidence that our universe is not alone"

CMB COLD SPOT



The cosmic microwave background (CMB), radiation left over after the big bang, bears an impression from when the universe was only around 400,000 years old. Its distinctive maps are littered with red and blue speckles representing the slightly hotter and cooler regions of the infant universe. Our understanding of the physics governing this period predicts that these variations should be small, and for the most part they are. However, in 2004, scientists using the WMAP satellite claimed to have found a cold spot significantly larger than the others. They thought it might be an error in their measurements. Then the European Space Agency's Planck satellite observed it too. An alternative model was badly needed.

Among the most promising remains the supervoid theory, a thorn in the side of those who defend the idea of a uniform universe (see main story). This proposes that a large patch of empty space sits slap bang in the direction of the cold spot. In order to reach us, CMB photons originating from beyond the supervoid would have had to pass right through it. Thanks to the accelerating expansion of the universe, the photons emerging from this barren area would find that matter was less densely packed than when they went in, leading to a drop in the gravitational potential they experienced, and consequently their energy. As photon energies are used to calculate a source's temperature, this would in turn lead us to incorrectly interpret their home region as colder than any other point on the sky.

GAS! GAS! GAS!

If you think the chemical horrors of the first world war were history, think again, says **Debora MacKenzie**

ON A bright day in late April, dignitaries gathered in the Belgian town of Ypres for a little-noticed commemoration: the hundredth anniversary of the first modern use of chemical weapons. Under a clear sky, representatives of the 1997 treaty banning such weapons – signed by almost every nation – reaffirmed the unacceptability of their use "anywhere, at any time, by anyone, under any circumstances".

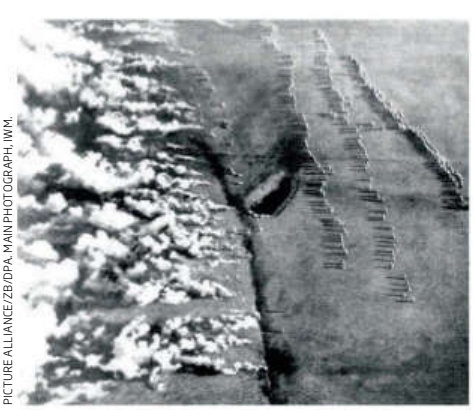
As they spoke, there were reports that the Syrian government was dropping chlorine on civilians and ISIS was resurrecting another first world war relic, mustard gas, probably a leftover from the 1980s.

So a century after Ypres, are chemical weapons coming back? Despite these recent atrocities, the global ban largely holds. Last year, treaty inspectors confiscated 1300 tonnes of mustard and nerve gas from Syria, largely unopposed. All countries except North Korea, Egypt and Israel have in principle declared their chemical weapons and almost entirely destroyed them, a unique achievement in disarmament.

But that doesn't mean the world is nearly free of chemical weapons – far from it. In many places, there are old, abandoned weapons that weren't in formal stockpiles when the Chemical Weapons Convention came into force in 1997. These forgotten relics still kill or injure people. Some could even be refurbished and reused.

The good news is that countries are finally paying attention. Next year, in installations around the world, several former chemical warriors will start erasing their pasts. The bad news: we have little idea how much more of this stuff is out there.

"There is no good global database of old and abandoned chemical weapons," says Paul Walker of environmental group Green Cross International. This is partly because there are few incentives to own up. The convention states that old weapons buried before 1977, or dumped in the sea before 1985, can stay where they are – but if you dig or fish them up, you must destroy them. That is difficult and expensive, so many turn a blind eye.



PICTURE ALLIANCE/ZB/DPA. MAIN PHOTOGRAPH, IWM.

A visit to Poelkapelle near Ypres shows how daunting the problem can be. In a small military facility, rows of sheds hold nearly 5000 rusting first world war shells, many filled with still-lethal chemicals. With a practised eye, Sven Devroe, operations officer for the Belgian military's bomb-disposal unit, points out German, French and British shells – and rapidly stops me from touching one. Despite all precautions, these antiques can leak. A few years back some mustard hit a worker's arm, raising an ugly yellow blister.

There are a lot more like these. An estimated 1.4 billion shells were fired in the first world war, of which 66 million were chemical. Of those, about 30 per cent failed to explode. Most of the duds ended up buried along the western front, 800 kilometres of trench that stretched from the North Sea to Switzerland. A further 13 million were never fired.

When the war ended, Belgium was riddled with unexploded and unused shells, and started dumping them in shallow water near Zeebrugge. In 1980, it dumped more in the Atlantic. Then a global treaty stopped sea dumping and by 2000, some 27,000 suspected chemical shells had accumulated at Poelkapelle. The base has destroyed nearly 19,000 since then. ›



A British 60-pound shell from the first world war, usually filled with phosgene (right); a poison gas attack in 1916 (left)

WEAPONS OF MASS DECEPTION

It was sunny around Ypres on 22 April 1915, with a light breeze from the north-east. German generals had waited weeks for that breeze. They had 6000 cylinders of chlorine buried in front of their lines near Poelkapelle. At 5 pm, the cylinders were opened. They emptied in 10 minutes, and a greenish-yellow cloud rolled towards the French lines.

The troops there were defenceless. As the gas rolled into their trenches, they died or ran – and kept dying, horribly, as the cloud followed them downwind. A gap opened in the lines, just as the Germans wanted. But they advanced only a few kilometres. Their commanders, seeing the attack as an experiment, hadn't positioned enough troops for a major offensive.

The Germans released four more waves of chlorine in the month-long battle that followed. But the lines of opposing trenches barely moved.

By September, Britain had enough chlorine to launch its own attack, near Loos in France. It was a disaster. Commanders ordered the canisters opened when the wind had died down, or even shifted towards their own lines.

This early history has led to chemical weapons gaining a reputation of being largely ineffective. Cynics claim the world was happy to ban them in 1997 for one simple reason: they don't work.

Experts concede that these weapons hardly deserve to be lumped together with nuclear and biological arms as weapons of mass destruction. But the human fear of poisoning and suffocation makes them uniquely horrible. "They remain potentially very effective for terrorists and sub-national groups to use against civilian populations," says Paul Walker of environmental group Green Cross International. They can also be effective on battlefields against ill-prepared troops. Iraq's chemical weapons killed 10,000 Iranian soldiers in the 1980s, and Japanese chemicals clinched several victories in China in the second world war.

Even though gas killed some 90,000 soldiers and injured a million in the first world war, Tim Cook of the Canadian War Museum in Ottawa has found that early histories of the war greatly downplay its military importance. The armies did give up on drifting clouds of chlorine, but they switched to artillery shells filled with more lethal chemicals such as phosgene.

Gas masks eventually cut the death rate of soldiers exposed to gas from 25 to 3 per cent. But many survivors were put out of action and the masks were hard to fight in and added to the debilitating stress on soldiers. Gas worked well enough to convince the generals. "By the last half of the war," says Cook, "gas was used in every engagement."

But farmers and builders keep finding more, 700 on average every year with no sign of it stopping. Last year, a farmer near Passchendaele uncovered a cache of 771 German shells, most containing mustard gas.

Destroying them is tricky. The failed charge can still explode, and working out what is inside isn't easy. The team at Poelkapelle uses X-rays and neutrons to identify the contents.

Some turn out to hold solid arsenic-based sneezing and vomiting agents that both sides used to force enemy soldiers to remove their gas masks before firing mustard or phosgene at them in a second salvo. The team wraps those in explosives and blows them up in a controlled detonation chamber. The heat destroys the explosive charge and chemical agent, and the toxic waste gases are removed in scrubbing stacks. The debris goes into an industrial incinerator.

> "Last year a Belgian farmer uncovered a cache of 771 shells, mostly mustard gas"

Others are filled with liquid – mostly chlorine, phosgene and mustard. The small ones are also sent into the chamber. Until 2012, the larger liquid-filled shells were drained, then the explosive charge was cut off and detonated, and the toxics incinerated. But that August, a German shell that had looked chemical in tests turned out to be packed with explosives. Cutting caused it to detonate. "No one was hurt, but we won't be using that equipment again," says Devroe.

In 2016, Poelkapelle will install a large static detonation chamber that can handle the biggest chemical weapons. It will be entirely automated, and use heat rather than explosives to destroy the whole shell.

France, in contrast, has destroyed none of its first world war chemical legacy. It had the longest stretch of the western front and its store at Suippes now holds about 17,000 chemical shells, all X-rayed and identified. The collection is expanding fast as shells are uncovered during the construction of a high-speed railway along the old front line.

So France, too, is installing a controlled detonation chamber that will operate from next year. The current stock of chemical weapons at Suippes alone will take 10 years to destroy, but the facility must also take care of weapons arriving from sites where shells are thought to be buried.

"I am afraid that France will not be able to clear those sites for a long time," says Dominique Anelli, head of chemical demilitarisation at the Organisation for the Prohibition of Chemical Weapons (OPCW), which enforces the chemical-weapons treaty.

Countries that didn't fight the first world war in their backyards have less of a problem. The UK and Germany had both finished destroying their leftovers by 2007 – although Germany is still cleaning the soil on a military base in Lower Saxony, where in 1919 a train loaded with unused chemical shells bound for France blew up.

The use of chemical weapons was banned by the Geneva Protocol of 1925. Countries still made and stockpiled them, but only Japan used them extensively in the second world war. That war's unused stockpiles were therefore easier to find and dispose of. Even so, a lot may remain. Some 500,000 tonnes of Nazi and Soviet chemical weapons may be buried in Russia or sunk off its coast, for example.

The US is the only country so far to have surveyed and declared all the places it suspects old chemical weapons might be buried. In 2007, it listed 194 potential sites. The US Army Corps of Engineers has only started clearing a few of them. They have been neglected partly because the main demand of the 1997 treaty was the destruction of all post-1946 stockpiles, which is still work in progress. In July, Russia said it had destroyed 85 per cent of the 40,000 tonnes it declared and would finish the rest by 2020. The US has incinerated 90 per cent of its declared 33,600 tonnes. It plans to finish the job, using detonation chambers, by 2023.

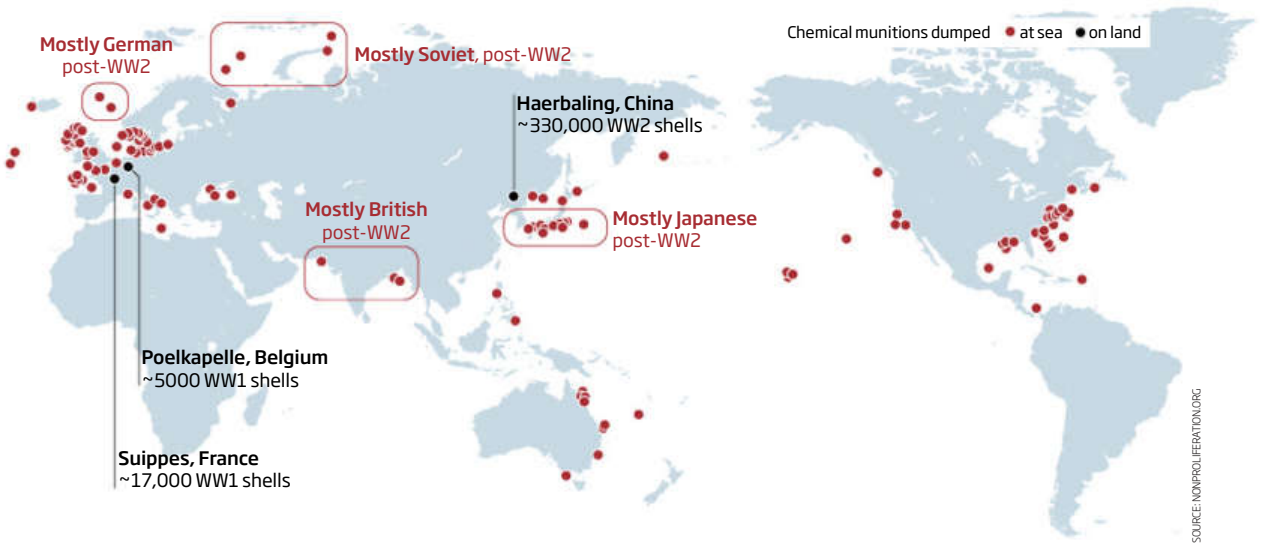
None of these backlogs, however, compares to that of China, where Japan stockpiled large quantities during its occupation from 1937 to 1945. China's reports to the OPCW say that Japanese mustard, phosgene and arsenic agents have been found in more than 90 locations, buried or dumped in rivers and lakes. They have killed and injured countless



PAOLO PELLEGRIN / MAGNUM PHOTOS FOR THE NOBEL PEACE CENTER

Out of sight

There are over 130 known chemical-weapons dumps, mostly containing Australian, British, German, Japanese, Soviet and US munitions from the two world wars and cold war. Many are badly documented, containing unknown quantities of unknown chemicals of uncertain origin



people, and injury rates are rising as China's building boom unearths more. More than 2000 chemical shells were found last year.

Under the treaty, chemical weapons left from the first world war don't have to be dealt with by the country that made them, partly because it is hard to attribute ownership. Those remnants are the responsibility of the countries where they lie. But chemical weapons abandoned in another country after 1925 are their maker's responsibility. Japan has spent more than $1 billion cleaning up in China. Some 53,000 tonnes were first collected in cities across the country, and two mobile detonation chambers have destroyed 38,000 tonnes of that since 2010.

Even that pales beside two huge pits at Haerbaling, where the Chinese buried an estimated 330,000 abandoned Japanese chemical weapons after the war. This year, Japan finished building two detonation chambers there. Full-time demolition starts next year, and the OPCW wants it cleared by 2022. But according to a joint Japanese and Chinese report to the OPCW in July, at current rates of destruction it will take 40 years.



At Poelkapelle in Flanders, the Belgian army is still fighting the first world war

Beneath the waves

But this may be dwarfed by what is lurking in the ocean. Because the 1997 treaty doesn't make countries declare chemical weapons dumped at sea before 1985, and dumping was banned afterwards, the data must be pieced together from historical sources. A recent map compiled by the James Martin Center for Nonproliferation Studies in California shows 127 known ocean dumping sites (see above). They include at least 147,000 tonnes in Russian Arctic waters and 220,000 tonnes of Nazi weapons in the Baltic Sea and Skagerrak Strait. The UK dumped 137,000 tonnes of second world war mustard and nerve gas shells in the Atlantic, and 1 to 2 million tonnes of mixed munitions in a trench in the Irish Sea. The US dumped at least 100,000 tonnes of chemical weapons off its own coasts, while Canada dumped thousands of tonnes of mustard gas off Nova Scotia. Some 15,000 tonnes, mainly mustard, were dumped off Australia. Old weapons in nets, especially oily globs of congealed mustard gas, have injured hundreds of fishermen over the years.

It isn't clear how ecologically damaging the dumps are. The Helsinki Commission on the Baltic Sea has found that mustard and nerve gas are broken down by marine microorganisms. Arsenic, however, persists and may contaminate fish: research in the Baltic suggests that marine fauna are unhealthier near dumps.

Dredging chemical weapons up for destruction could just make a worse mess, says Bob Mathews of Australia's Defence Science and Technology Group. "The best thing is to just let them degrade."

Whether sea-dumped chemical weapons are retrieved should be assessed case-by-case, says Anelli. Those with arsenic or other pollutants that won't degrade, especially in shallow water near coasts and fishing zones, maybe. Those in deep water with only organic molecules that will degrade, maybe not. First, he says, we need a more detailed map.

All this has a wider significance than just cleaning up historic pollution. The treaty is really about stopping proliferation, and there is still a real risk of that. Chemical weapons are cheaper than nuclear and, as recent events have shown, useful in urban warfare and for attracting attention. Apart from Syria, both Iraq and North Korea have developed them, and other countries are suspected of doing so.

A ban on chemical weapons is hardly served by a world awash with them, even if they are old and abandoned. If nothing else, the expense of dealing with this mess shows that banning chemical weapons is a good idea. The last thing the world needs now is more ammo dumps full of chemicals designed to kill and maim. ■

Debora MacKenzie is a consultant for *New Scientist* in Brussels

Short circuit

Deep brain stimulation has had amazing results, but failures are flagging up its limits, finds Andy Ridgway

A REVOLUTION in neuroscience seems to be under way. It has allowed a 13-year-old autistic boy to speak for the first time. It has freed people with Tourette's from physical tics so severe that they broke bones. It has stopped people with obesity from overeating and prevented those with anorexia from eating too little.

The revolutionary therapy is deep brain stimulation, a treatment that uses electrodes implanted in the brain to bring problematic behaviours under control. It established its bona fides by releasing people with Parkinson's disease from some of its most debilitating symptoms, and over the past decade or so the range of mind and brain disorders for which it has been used has been widening steadily. Its dramatic successes have led to calls to extend its use still further, perhaps even to curb paedophilic or psychopathic desires (see "The off-switch for desire", page 40).

Recently, however, this wonder treatment has been dealt a grievous blow. Two failed clinical trials have left neuroscientists at an impasse about how widely the treatment should be used, and brought ethical questions from the periphery into the spotlight.

As surgeries go, deep brain stimulation is fairly straightforward. A rigid frame is attached to the patient's head, and then two holes are drilled into the skull. Through these, the surgeon pushes two metal electrodes, each about the diameter of a piece of spaghetti, to the region of the brain responsible for the symptoms. "Stick a knitting needle through a piece of butter and it's exactly the same feeling," says Thomas Schläpfer, a neurosurgeon at University Hospital Bonn in Germany. In a second operation, a pulse generator about the size of a stopwatch is implanted under the collarbone and connected up to the electrodes by a lead beneath the skin. Over the following couple of weeks, a technician will adjust the flow of electricity into the brain by tweaking parameters like voltage and pulse frequency, until it hits a sweet spot.

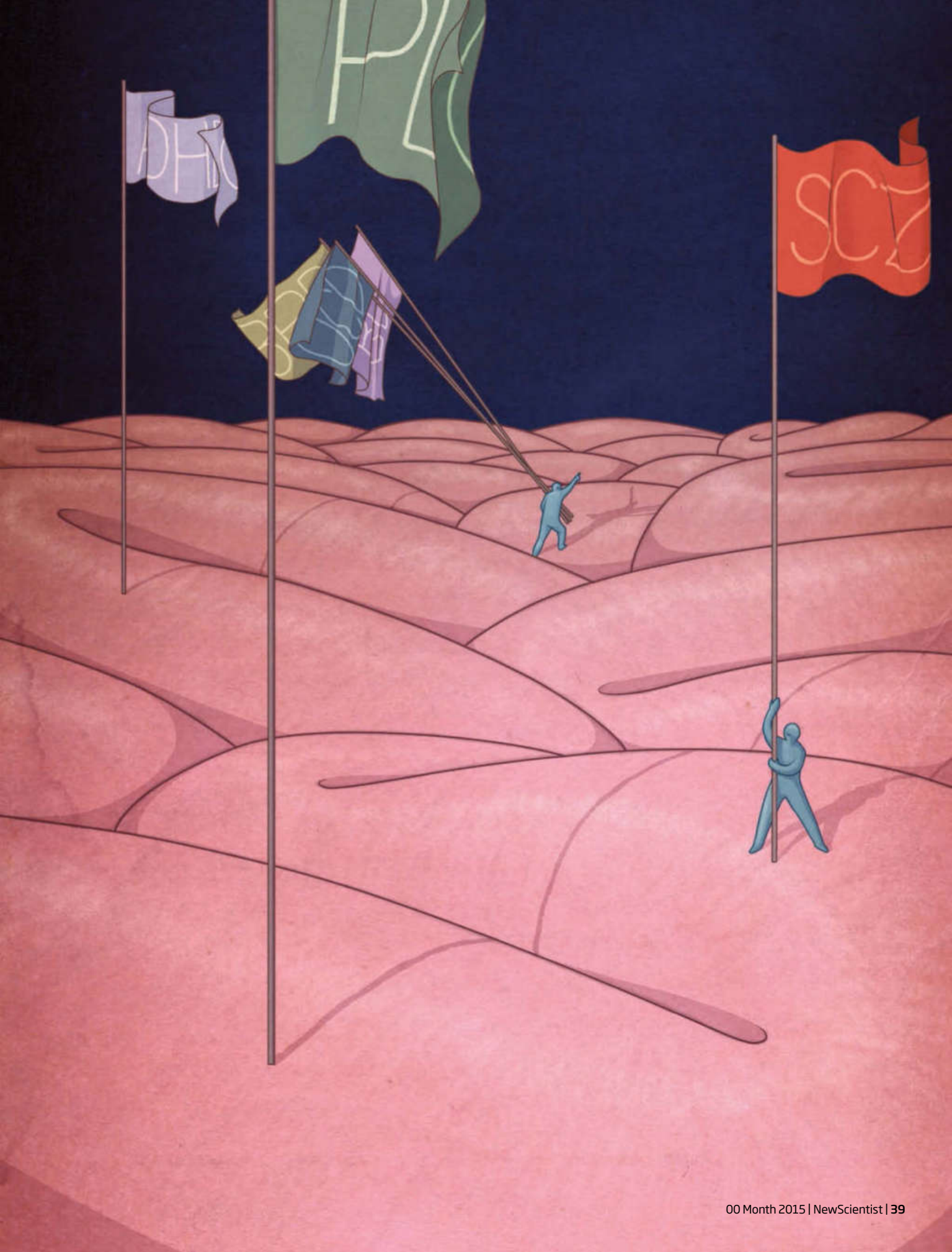
Pacemakers for the brain

It is hard to overstate the effects. Tremors disappear at the flick of a switch. A person who could not hold a cup of tea can suddenly keep their hands motionless. Since the treatment was approved in Europe and the US in the mid-1990s, more than 100,000 "brain pacemakers" have been implanted to mitigate the disabling muscle spasms of people with Parkinson's, essential tremor and dystonia. For these, large-scale trials backed the treatment's efficacy.

On the back of such successes, in 1999, researchers at the Catholic University of Leuven (KUL) in Belgium offered it to four people with severe obsessive-compulsive disorder. For three of them, symptoms improved. Since then, small trials involving ailments ranging from anorexia to tinnitus, and even drug addiction, have followed in rapid succession (see chart, page 41).

For most of these conditions, deep brain stimulation has so far been approved only on an experimental basis, for use in small studies, typically without a control group. Although there is much anecdotal evidence of its ›

RICHARD WILKONSON


SCZ

ability to treat psychiatric conditions, there has never been any large-scale proof that it works well for anything other than Parkinson's and other motor disturbances.

Two major trials looked poised to change that, testing deep brain stimulation's apparently great promise in reining in treatment-resistant depression. "We see this as a malignant form of depression, with suicide being a major risk," says Helen Mayberg at Emory University School of Medicine in Atlanta, Georgia. Hers is one of several research groups who have been working in this area for more than a decade. Twenty small trials had recorded improvement rates as high as 60 or 70 per cent. "People come out of that very dangerous state, and stay well," says Mayberg. "They just get back on the bus."

These results convinced equipment manufacturers St Jude Medical and Medtronic to invest millions of dollars in setting up two large-scale controlled trials. Judging by the positive results of the smaller trials, these should have been a slam dunk. Instead, they failed.

There were no warning signs. "I was quite surprised," says Darin Dougherty, director of the Division of Neurotherapeutics at Massachusetts General Hospital, who was involved with the Medtronic trial. The published results show that after 16 weeks, there was no significant difference between the active and control groups (*Biological Psychiatry*, vol 78, p 240). St Jude Medical has not yet made its trial data available, but told *New Scientist* that its decision to end the trial was "based on a low probability of success". Not only was stimulation ineffective in many patients, but some of their symptoms got worse – and a few people developed new ones.

> "Failed trials show that we don't really know how the treatment alters minds"

St Jude Medical says it is still investigating the use of deep brain stimulation for treating depression, but Medtronic has formally withdrawn from commercialising the therapy.

"Medtronic and St Jude have spent millions and millions of dollars to have two negative trials," says Dougherty. And it's not just the device-makers who have been stung. The failed trials have highlighted some troubling realities about deep brain stimulation. Knowledge is improving, but we still don't really know how it alters people's minds.

"We've learned a tremendous amount about the biology," says Michael Okun, a neurologist at the University of Florida in Gainesville, who has overseen more than 800 implants for Parkinson's. The electrodes have the effect of inhibiting some neurons and exciting the fibres that link one neuron to another. Neurochemicals like adenosine and glutamate are released. Stimulation also has effects on the whole brain, affecting the rhythmic activity of its neurons. But working out which of these effects, singly or in combination, results in tremors stopping or OCD symptoms lifting – "that's tricky," says Okun. This hasn't mattered too much with Parkinson's and tremor; the stimulation just works. But it assumes new significance if the goal is to expand adoption to conditions that affect the brain in more subtle ways.

It's also unclear what causes the side effects. Some could almost be considered endearing: while being treated for OCD, one man in the Netherlands suddenly developed an exclusive taste for Johnny Cash. After he was "deeply affected" by a chance encounter with the song *Ring of Fire*, all other artists were "banned" while the brain stimulation was working. Not all side effects are so benign. People with deep brain stimulation implants to stop Parkinson's symptoms have reported an increase in impulse control disorders, such as excessive gambling and hypersexuality. Treatments for other conditions have resulted in similar symptom "spillovers". In the St Jude trial, reports of side effects were in keeping with these accounts. The published report on the Medtronic trial states that the "psychiatric adverse events" included worsening depression and suicidal thoughts.

The side effects of deep brain stimulation have always been recognised, and that's why it has largely been considered a treatment of last resort. But now it looks as if we need to rethink the cost-benefit analysis for using electricity to treat psychiatric conditions. While it would be easy to conclude that the treatment should be put on hold as we ponder the ethical dilemmas it raises, withholding it could have worse consequences. "It would be almost unethical, if you think you could improve this patient's poor quality of life, to not offer a treatment," says Dirk De Ridder, a

THE OFF-SWITCH FOR DESIRE

DIRK DE RIDDER uses an unusual treatment for alcoholism. A neurosurgeon at the University of Otago in New Zealand, he has tried deep brain stimulation on three people for whom all previous treatments had failed; one was drinking to the point of losing consciousness each night. "The first results have been very promising," says De Ridder. His next target is obesity, reflecting the trend to test the treatment on an increasing range of conditions.

De Ridder is among those who wonder whether deep brain stimulation could also curb the more harmful or violent urges of convicted paedophiles or psychopaths, for example. "Moral dysfunction" – as he calls it – yields to few, if any, non-invasive long-term treatments. Reoffending rates among criminal psychopaths hover around 70 to 80 per cent. This, he and others argue, justifies the experimental study of invasive treatments. In 2011, one neurosurgeon suggested that implanting electrodes could instil psychopaths with a capacity for remorse.

Apart from the potential side effects (see main story), would this be ethical? Julian Savulescu, an ethicist at the University of Oxford, is not completely opposed. "If it were safe and effective, and the individual preferred to use deep brain stimulation in exchange for a shortened prison sentence, this might be justifiable," he says.

But Savulescu is uneasy about a deeper issue arising from using the treatment to subdue urges. "Probably the most controversial neurointervention would be to bring desire under close cognitive control," he says, because it has implications for freedom and autonomy.

However, certain conditions also affect our capacity for conscious control. "OCD and addiction decrease the ability to choose freely," says De Ridder.

It's all down to how you view the brain, says De Ridder. "One point of view is that we should not interfere with it whatsoever," he says. However, see the brain as just another organ, like the liver or kidneys, and there is no ethical problem with improving its function, he says. In this light, deep brain stimulation is simply a treatment that restores control to those who have lost it through mental illness.

neurosurgeon at the University of Otago in New Zealand.

For some people, deep brain stimulation can be a godsend. "I've seen patients in the open-label trials who were considerably ill who improved and got their lives back," says Dougherty. Could something other than the treatment account for this? "It would be hard to explain the improvements we have seen over seven years by placebo," says Schläpfer.

In light of these inconsistencies, many neuroscientists say the failed trials are not an indication of a failed treatment, but may point the finger at the way they were set up and run. "Both of these trials had lots of problems with protocol design", says Schläpfer. For starters, the initial trial periods (four months in the Medtronic trial and six in the case of St Jude) were simply too short to reveal subtle improvement in symptoms.

That gets to the issue of proof. In Parkinson's, the success of a treatment is obvious – the tremors cease. But with the complex collection of symptoms that characterise a mental illness such as depression, the effects of treatment are less obvious and more subjective. "Are you better if your sleep, appetite and libido improve, but you still feel disinterested and suicidal?" says Mayberg. She also wonders whether some gains may have been masked by reliance on subjective, rather than quantitative, assessments.

Real-time insights

Mayberg thinks the trials highlight the importance of finding measurable biological markers of depression. New technology may help. She is one of a handful of researchers to whom Medtronic have given prototype pulse generators that give live readings of electrical activity in the tissue surrounding the electrodes during brain stimulation. The idea is to identify which changes in brain activity signify that deep brain stimulation has defeated depression. "We're learning for the first time what we are doing in real time when we are stimulating," says Mayberg.

But there may be a more general problem with using existing forms of deep brain stimulation to treat mental illness. Many of the disorders in neuroscientists' cross hairs occur in intermittent episodes, so perhaps delivering electricity constantly isn't the best approach.

It's a subtlety that Dougherty is trying to address. As part of the BRAIN Initiative in the US, he is aiming to treat post-traumatic stress disorder, characterised by episodic anxiety and panic attacks. His group has a $30 million grant to develop a more responsive kind of deep brain stimulation. Instead of simply delivering continual current, this would monitor specific brain regions for the telltale oscillations of an impending episode. Only then would a sensor flick on the electricity. He thinks it is the key to unlocking deep brain stimulation for mental illnesses, including depression and substance abuse.

All of this work will begin to provide a "cartography" of mental illness, a map of the parts of the brain that give rise to specific symptoms. That would revise our understanding of mental illness, says Joseph Fins, a medical ethicist at Weill Cornell Medical College in New York. For example, depression might be split into different subtypes, each linked to a different network of the brain, and each treated by electrically stimulating these specific regions.

For now, however, we still have much to learn about deep brain stimulation, as the failed trials showed. A note of caution is warranted, especially as the treatment is beginning to make headlines, prompting people to look to it for things other than actual illness. Over the past two years, Okun says he has had enquiries from people who have no psychiatric problems and simply want their memory or mood enhanced. "This is a horizon we're going to have to watch," he says.

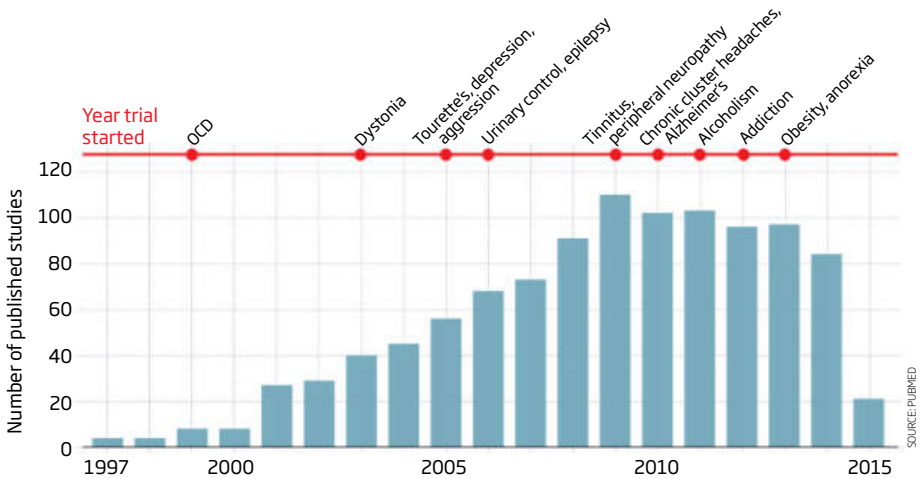
Dougherty agrees. "You don't want to get into the mentality of putting the first flag on the moon, where you just grab a patient with a disorder that hasn't been studied yet and say, 'hey, we did the first one'," he says. "People do that, it's amazing."

Okun has a self-imposed ethical principle: "We will apply the technology only for one reason, and that is to alleviate human suffering." ■

Andy Ridgway is a writer based in Bristol, UK

Trial by electricity

Since the US Food and Drug Administration approved the use of deep brain stimulation for Parkinson's in 1997, the therapy has been investigated for an increasing number of other conditions





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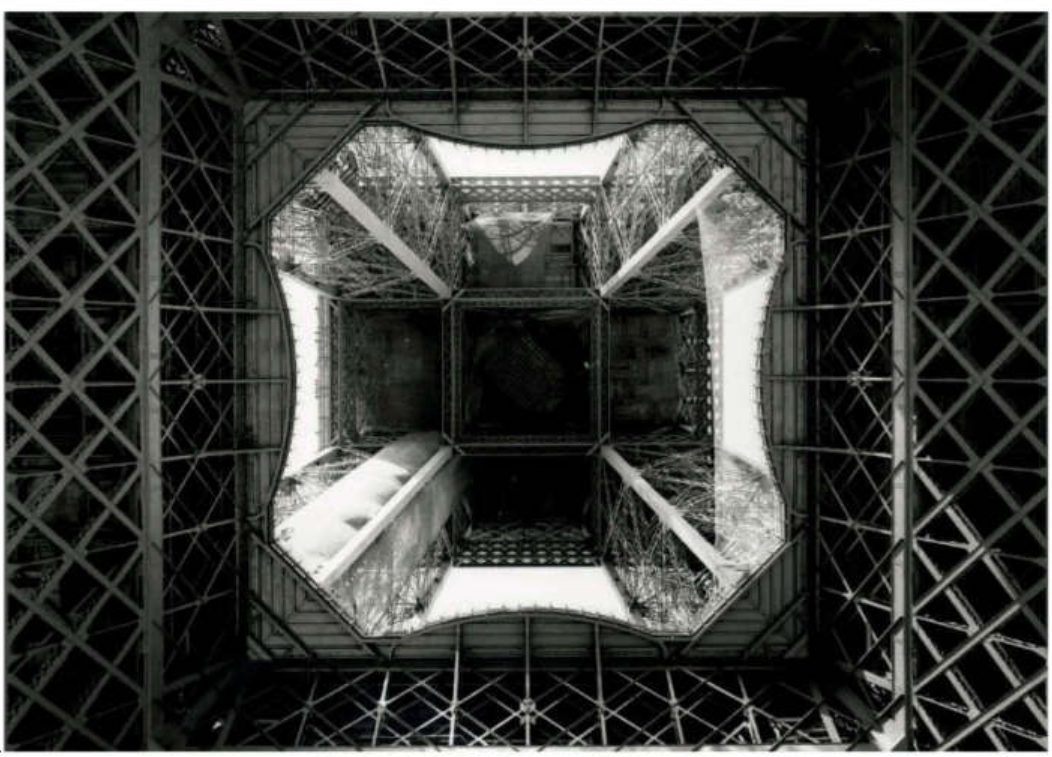
From Parkinson's to anorexia, symptoms can be eased by a zap

Delusions of design

Free-market evangelism spoils a good book on evolution, finds **Graham Lawton**

The Evolution of Everything: How ideas emerge by Matt Ridley, Fourth Estate, £20





JEAN VANLAER/MILLENNIUM IMAGES, UK

FOR most of history, humans were instinctive creationists. Faced with the intricate perfection of an eye or a wing, they jumped to the conclusion that it was designed by an intelligent creator, aka God.

Then along came Darwin and proved the obvious wrong. The appearance of design is an illusion; biological order arises by slow, undirected trial-and-error coupled with natural selection, aka evolution.

Evolution now reigns supreme as the explanation of biological complexity. But, according to veteran science writer Matt Ridley in his new book, *The Evolution of Everything*, most people remain instinctive creationists. Even those who have no trouble with biological evolution fail to see it at work elsewhere, especially in human culture and institutions.

So when we encounter a complex human system, we default to the assumption that it is the product of design. But just as with eyes and wings, this appearance is an illusion; successful human institutions emerge from the bottom up, driven by natural selection among competing ideas.

That is the central thesis of this highly readable, invariably interesting but ultimately maddening book. The Darwinian revolution is unfinished, says Ridley; like relativity, the theory of evolution should be considered a "special theory", applicable only in the limited sphere of biological change. It needs to be extended to a "general theory", which also applies to the human world.

Ridley's laudable aim is to disenthral us of our intuitive creationism and make us see evolution at work everywhere: "I want to do for… the human world a little bit of what Charles Darwin did for biology, and get you to see past the illusion of design, to see the emergent, unplanned, inexorable and beautiful process of change that lies beneath."

By that measure, Ridley succeeds in spades, with lucid accounts of the evolution of culture, technology, the economy, the internet and more. In full flow, he possesses the rare power to see the world in a different light – one made not by great men or women but by undirected, incremental change.

"The appearance of design is an illusion; biological order arises by slow, undirected trial and error"

If Ridley had left his ambitions at that, this would be a very good book. But he doesn't, and it suffers as a result. His argument quickly – and predictably, for anyone who read his previous book, *The Rational Optimist* – degenerates into a manifesto for unfettered free markets and right-wing libertarianism. This leads to familiar neo-liberal territory: the state should limit itself to defence of the realm and enforcing the law – and then get out of the way.

Evolution is everywhere, even in the cultural artefacts around us

In this world view, top-down solutions only lead to failure, if not disaster. This is undeniably true in many instances, as the history of the 20th century attests. But he lets evangelism get the better of him, and ends up striding blindly into another human fallacy, the is/ought problem: just because many successful institutions evolved, all institutions ought to be created thus – in other words, left to market forces.

But as a prescription rather than a description of how human society works, evolution swiftly loses its appeal. The human world of which Ridley writes is not just composed of cultural entities,

institutions and inventions, but of real people. For them, a Darwinian world is a brutal one where only the very fittest survive.

Perhaps that is why Ridley has to cherry-pick so furiously to disguise or deny the human cost of his – let's not shy away from it – social Darwinism. For example, he trumpets the achievements of private schools, but somehow fails to mention that this may have something to do with their ability to select the brightest students from the wealthiest backgrounds. And he claims that, had the NHS not been created, private health provision in the UK would have evolved into a market-driven system that "catered to the needs of all, especially the poor".

This, at least, begs him to defend the brutal US system, which left about 50 million, mostly poor, people without health coverage until the state stepped in. If this could be blamed on heavy-handed regulation, you can bet that Ridley would have laid the blame there (as he does for the 2008 financial crisis, in which he was a key player as chairman of the failed UK bank Northern Rock). But the free market gets a free ride.

Even more astonishingly, he tells us that "global inequality is currently falling fast" – a claim so counter to the dominant narrative that it demands explanation. But beyond saying that people in poor countries are getting richer faster than people in rich countries (are they? by what measure? over what time period?), we don't get one.

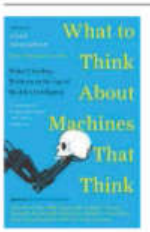
Ridley's is a fundamentalist world view that brooks no dissent; everything can be twisted or elided to support the argument. This seems lost on him, even as he gleefully skewers Freudianism and other pseudoscientific theories of the human condition: "The characteristics of a mystical, and hence untrustworthy, theory are that it is not refutable, that it appeals to authority, that it relies heavily on anecdote… and that it takes the moral high ground." Indeed. ■

Thinking about thinking

Fun or heft? Finding the right balance is tough in an anthology on AI

What To Think About Machines That Think: Today's leading thinkers on the age of machine intelligence edited by John Brockman, Harper Perennial, £8.99

Liz Else and Simon Ings



ONCE again, cultural wizard John Brockman has stirred up the intellectual waters with a provocative question, designed to tease the best out of intellectuals working in or around science and technology.

But this time, there's a bit of a snag with the conceit. Brockman's questions are usually studiedly general, from what scientific idea is ready to die to how is the internet changing the way you think. A key feature is the fun mashing and crashing of wildly disparate approaches and ideas from many, equal participants.

Here, however, the question is very specific: what to think about machines that think. So the major players in this field are in danger of unbalancing the rest because they are involved in (or have spent time thinking about) the hefty issues underlying such machines. In short, they are in danger of knowing whereof they speak.

Machines that think will have to recognise human intelligence

So we have heavy hitters like roboticist Rodney Brooks, whose experience tells him to proceed cautiously with words like "think"

"If we build machines that think, will we bother to think much? It's one of the big questions left hanging"

because they are "suitcase words – words into which we pack many meanings so we can talk about complex issues in shorthand". They can lead us into the kind of category error comparable to seeing "the rise of more efficient internal combustion engines and jumping to the conclusion… warp drives are just around the corner".

Then there's Stanislas Dehaene, a cognitive neuroscientist for whom we are two big problems away from thinking machines: global workspace (how the mammalian brain shares information contained in different parts of the brain), and theory of mind (circuits that help us represent other minds so we can understand and adapt to them). These are functions even a 1-year-old child possesses, he says, "yet our machines still lack".



VINCENT FOURNIER/GALLERYSTOCK

All good reality checks, but it's a relief to turn to Joichi Ito, director of the MIT Media Lab, who has better things to worry about, in particular, the paradox that "while we've been developing machines that behave more and more like humans, we've been developing educational systems that push children to think like computers". For Ito, thinking machines will obviate the need to train our children this way.

And given systems that alleviate our wants, we will be free to become superhumanly accomplished, tender and wise. Or something like that. But we already know that this won't work. We are evolved organic beings, and have acquired an annoying habit: we conserve energy. We hanker after rest and security; when we find it, we settle down for a little nap. If we build machines that think, will we bother to think much? This is one of the big questions left hanging over Brockman's excellent, if uneven, anthology.

Another is this: it is all very well to assume that our machines of loving grace (to steal a phrase from Richard Brautigan's poem) will mean us no harm. But they have to notice us first. They have to recognise *our* intelligence. ■

Foraging for the future

Lisa Ma finds a sustainable global business thriving at society's margins

The Mushroom at the End of the World: On the possibility of life in capitalist ruins by Anna Lowenhaupt Tsing, Princeton University Press, $29.95/£19.95



THERE is a fungus often given as a gift in Japan that cannot be cultivated. But it was the first thing to grow in the area after the atomic bomb fell on Hiroshima.

This ability to survive is perhaps part of the reason matsutake are such a desirable commodity. In Japan, they are synonymous with fertility, longevity, autumn and the changing of the seasons.

But the trees the mushrooms grow under have been plagued by infection, and matsutake are becoming rarer in Japan. Good, local specimens can sell for $200 each and they are also imported to meet demand. All of this gives a society that values the mushroom the chance to balance ecological and economic needs in new ways, says anthropologist Anna Lowenhaupt Tsing in *The Mushroom at the End of the World*.

And the effects are felt in other countries and communities. Deep in the Cascade mountains in the US, Asian immigrants and refugees gather to harvest matsutake for cash. Disparate communities of Mien, Hmong, Lao and Khmer form separate campsites, sharing pho soup, tripe broth and the odd shot of scorpion alcohol in a nostalgic recreation of a past village life.

The global business of gathering matsutake mushrooms is thriving

Many are equipped with jungle skills from the Indochinese wars and hunting for matsutake is both a salve for their war traumas and a livelihood. For them, matsutake provides a welcome alternative to factory work, and a way of avoiding cultural assimilation.

Forests have always been a haven of refuseniks, from Robin Hood to the Unabomber, but Tsing's description of the free-market mechanism sustaining these mushroom-picking "renegades" is surprising. This fringe community, she says, sustains "Japanese-sponsored supply chains because of their overlapping yet diverging commitments to the freedom of the forest". She then expands on her ideas about where humans sit in the natural order of things.

Tsing writes detailed accounts of her encounters with unfamiliar and complex people. She has little time for hand-waving, and finds something conceited in the term "Anthropocene". Human activities may have become the main impact on Earth, but they do not happen in a vacuum. What about those moments and places where humans and non-humans converge to achieve "collaborative survival"? Tsing's idea of ecology makes room for human participation. She allows us to handle and enjoy the world. And she celebrates the way certain activities, particularly foraging, maintain biodiversity.

"Many Japanese say they fantasise about eating matsutake as though it were merely food"

At the other end of the supply chain, mushrooms are distributed according to a strict code. The wholesalers and auctioneers in Japan are matchmakers rather than salespeople, and ensure that this rare produce is appropriately assigned to the right clientele and occasion.

Matsutake is much more than a commodity. As a gift it plays an important role in marriages and other ceremonies to do with long-term relationships. In fact, the mushroom is so loaded with convention, many Japanese admit to indulging defiant fantasies in which they devour matsutake as though it were merely food.

Tsing builds a panoramic account of traditional peasant land rights, and how researchers in places as far apart as Japan, China and Finland are beginning to consider their ecological value.

Tsing's book is more than just another microhistorical study. Her case studies give inspiration to those of us who rant about ecological problems but fail to produce tangible proposals. The matsutake fungus and the people involved in its distribution live "in spite of capitalism", she says, and in spite of those who would preserve nature in some notional "pristine" state.

Tsing has an idea of ecology that allows us to touch, use and care for the world without the scolding that usually follows. It might be somewhat idealistic to suggest that our future could be saved by the system she describes, but there may be ways to apply the idea to other walks of life. ■



TODD BIGELOW/AURORA PHOTOS

Lisa Ma is a speculative designer

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Minority report

STEM may be on the cutting edge of research, but when it comes to embracing diversity, old perceptions can linger. **Laura Dattaro** investigates how science is shedding its stereotypes

FROM FINDING cleaner sources of energy to feeding a ballooning population, the needs of the 21st century demand all hands on deck in science and engineering. But while the US becomes increasingly diverse, STEM isn't keeping up. Though black people make up more than 12 per cent of the population, they comprise just 5 per cent of the science and engineering workforce, with similar trends seen among Hispanics. And, even if they do follow STEM careers, racial minorities often receive lower pay, with gaps in average salaries as high as $13,000.

This lack of diversity can put companies and universities working to solve increasingly complex problems at a disadvantage. Employing staff from a wider range of backgrounds can bring in the new perspectives needed for innovation, ensure the brightest minds are on board and increase a company's customer base and its bottom line. "Our country is becoming more and more diverse every day, and we have to embrace that and capitalize on that," says JoAnn Trejo, professor of Pharmacology, University of California, San Diego, who leads a postdoctoral program designed to increase diversity in the biomedical sciences. "That diversity brings value."

Investing in outreach

For minority students who also come from low-income backgrounds, financial support can be the key to earning the advanced degrees needed for STEM careers. Many minorities are also first-generation college

students, and are likely to benefit from training in professional skills, like resume and grant writing. "It's not just about financial capital," says Chad Womack, a director with the United Negro College Fund (UNCF). "It's also about social capital or mentoring – intangible forms of capital that to some extent are worth more."

To that end, for 20 years UNCF has partnered with pharmaceutical giant Merck to fund African-American students and researchers. The program has paid out more than $40 million to nearly 700 fellows – among them NASA astronaut Robert Satcher, who flew on the space shuttle Atlantis. "As the country's demographics change toward a much more diverse population, I think it's important that our industries reflect that diversity as much as possible," Womack says. "We've got a long way to go."

"If you put in the effort, the students will draw to these programs"

Other companies have been following suit. For example, earlier this year, Intel set aside $300 million to fund engineering scholarships and other efforts with the aim of increasing its minority staffers by 14 per cent in five years. Even companies without big financial investments can make a difference, says Gabriel Montaño, a biophysical chemist at Los Alamos National Laboratory and president of the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS). "It's about smart investment," Montaño says. "You can't invest in just box-checking exercises or throwing money at a problem. We've got to get creative."

Recruiting for all races

Hiring committees also need to make a concerted effort to include minority candidates. Universities often exclude minorities by restricting their searches to traditional, usually elite, schools, which tend to have predominately white student bodies. "Once that happens, you automatically create as one of your criteria a non-diversified pool," Montaño says.

Opening up search standards can help ensure qualified candidates from minority backgrounds get a fair shot at the top jobs or a first job that could launch a career. Hiring committees can also lean on organizations like SACNAS, UNCF, the Hispanic Association of Colleges and Universities (HACU) and universities that predominately serve black and Hispanic students. These organizations often host conferences that can help both academic and industry institutions find lots of promising talent.

"Our country is becoming more diverse and we have to embrace that"

Universities can do more to reach out in their communities and host events, Womack says. Since 1991, Harvard has run the Biomedical Science Careers Program, which partners with medical centers, private industry and others to mentor minorities in the biosciences at all stages of their careers. And among scientific societies, the American Society for Microbiology has made significant efforts to support minority students, hosting the Annual Biomedical Research Conference for Minority Students to connect students with industry leaders who can help start their careers. Over the past 15 years, attendance has increased from 1,800 to nearly 4,000, says conference project manager Irene Hulede. "It shows that there is a need," she says. "If you put in the effort, the students will draw to these programs."

Unloading the dice

All of these efforts can help, but they must be accompanied by a serious desire to change the way minorities and other under-represented groups are treated in STEM careers. Unintentional biases can creep into classrooms, laboratories and boardrooms, preventing qualified future scientists from moving forward. A 2011 study commissioned by the National Institutes of Health (NIH) and published in *Science* found that black scientists were 10 per cent less likely than their white counterparts to receive an important grant from the NIH, leading the authors to suggest this showed possible unconscious racial bias. For their part, the NIH responded positively, launching Building Infrastructure Leading to Diversity (BUILD), a $500 million, 10-year program to help minority scientists.

"You can't invest in just box-checking exercises. We've got to get creative"

Diverse selection committees can help, Trejo says, while Montaño suggests committees alter their hiring processes to consider the whole candidate. Focusing only on statistics, like GPA and the amount and pedigree of published papers, can diminish the extra effort it may have taken for a first-generation college student to earn a PhD. "The assumption that's made is that all these candidates start at the same place, so they've all demonstrated the same potential in their education," Montaño says. "I would say that is probably the biggest mistake that is made and it needs to be corrected." ■

Laura Dattaro is a reporter in New York specializing in science and the environment

CASE STUDY
SHOOTING FOR THE STARS



KALI NINE LLC/GETTY

WHEN JOHN ASHER JOHNSON started college, engineering seemed a natural fit. But classes at the University of Missouri-Rolla (now the Missouri University of Science and Technology) failed to grab his attention. It wasn't until he tried physics that he found engaging classes and met his mentor, a professor who encouraged him to apply to Berkeley's graduate program in astronomy.

Now a professor of astronomy at Harvard University, Massachussetts, where he studies exoplanets (planets beyond the solar system), Johnson founded and leads the Harvard Banneker Institute, an intensive summer program for ethnic minorities, women, those with disabilities and others who have been marginalized from STEM. Its combination of research, professional training and social justice seminars has helped make Harvard's astronomy graduate program among the most diverse in the country: 44 per cent women and 43 per cent people of color. "You don't have to give up excellence to get diversity," Johnson says. "It's the other way around. You get excellence by achieving diversity."

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KANSAS STATE UNIVERSITY

ASSISTANT/ASSOCIATE PROFESSOR SOFT MATTER EXPERIMENT CONDENSED MATTER GROUP DEPARTMENT OF PHYSICS

The Department of Physics at Kansas State University seeks an experimental physicist with research interests in soft condensed matter physics. Areas of interest include nanoparticle assembly, biological problems at the cellular and molecular levels, emergent phenomena, macromolecules, structured fluids, colloids and aerosols, and light scattering and its application to these systems. Such a scientist might engage in experimental research at the molecular or continuum levels of these physical or biological systems. Cross disciplinary research plans that overlap with ongoing AMO projects in the department (strong field laser-matter interactions, plasmonics, ultrafast charge transport) will be reviewed with interest, but are not required. The successful candidate will be appointed at the rank of tenure-track Assistant or Associate Professor in the Physics Department. Candidates must have a PhD in physics or a closely related field. To be considered for the Associate level position candidates must present credentials which will justify appointment at that level. The successful candidate should also demonstrate a strong commitment to teaching and mentoring of students and to serving a diverse population.

The Department has outstanding experimental and theoretical Condensed Matter physics programs involving seven faculty members most of whom are involved in research related to soft matter physics. Faculty research interests include synthesis and self-assembly of nanoparticles, surface structure and surface interactions of nano/bio components, light scattering, metallic and conducting polymer nanowire fabrication and applications, cellular adhesion and migration, aggregation phenomena for both proteins and particles, and nanostructured magnetic systems. The soft matter group has strong ties and collaborations with faculty in Chemistry, Biology, Biochemistry, Mechanical Engineering, Chemical Engineering, Grain Science, and the Terry C. Johnson Center for Basic Cancer Research. A description of research in the physics department can be found at:

http://www.phys.ksu.edu/research/condensed-matter.html

Applications should be sent to **The Condensed Matter Search Committee, 116 Cardwell Hall, Kansas State University, Manhattan, KS 66506-2601** or to **softmattersearch@phys.ksu.edu**. In addition to a curriculum vita, applications should include statements of research and teaching interests. Candidates should arrange for three (3) letters of reference to be sent as well.

Kansas State University is an equal opportunity employer and actively seeks diversity among its employees. Background check required.

KANSAS STATE UNIVERSITY

Assistant/Associate Professor Physics Education Research Kansas State University

The Department of Physics at Kansas State University seeks a faculty member to join its physics education research (PER) group. Experience with research on the teaching and learning of physics that complement and/or expands the existing PER efforts at KSU will be considered favorably. The successful candidate will be appointed at a rank of tenure-track Assistant or Associate Professor in the Physics Department. Candidates must present credentials which will justify appointment at one of these levels. Minimum requirements include a Ph.D. in physics education research or equivalent and research experience beyond the doctorate.

The Department has an outstanding physics education research program (KSUPER), which was founded in 1972. At present KSUPER includes two faculty members. A detailed description of research activities, post-docs and graduate students in KSUPER can be found at **http://www.phys.ksu.edu/ksuper**. For further information contact Eleanor Sayre (**esayre@phys.ksu.edu**) or Dean Zollman (**dzollman@phys.ksu.edu**).

The successful candidate will also demonstrate a strong commitment to teaching and mentoring of students and to serving a diverse population. He/she will be expected to obtain external funding for research activities, collaborate with other faculty in physics and other academic departments and build a national and international reputation in PER.

Applications should be sent, to **PER Search Committee, 116 Cardwell Hall, Kansas State University, Manhattan, KS 66506-2601** or to **persearch@phys.ksu.edu**. Applications should include a cover letter that addresses qualifications for the position, a curriculum vita, and statements of research and teaching interests. The applicant should arrange to have three letters of reference sent to the address above.

Screening of applicants will begin on December 1, 2015, and continue until the position is filled.

Kansas State University is an Equal Opportunity Employer of individuals with disabilities and protected veterans and actively seeks diversity among its employees. Background checks required.

UNIVERSITY OF WATERLOO | IQC Institute for Quantum Computing

Faculty Position

Applications are invited for 1 or more tenure-track faculty positions, at the rank of Assistant Professor in the Institute for Quantum Computing (IQC) and any department in the Faculties of Mathematics and Science. The IQC is a collaborative research institute focused on realizing quantum technologies including sensors, actuators, quantum communication, and information processors. Membership in IQC is renewable, with an initial appointment of 5 years, and comes with research space, a teaching reduction of one course and a stipend. Only those candidates whose research program directly connects with the goals and ongoing research in IQC will be considered. Information about research at IQC can be found at **http://uwaterloo.ca/iqc/research**.

A PhD and significant evidence of excellence in research in quantum information science and technology and the potential for effective teaching are required. Responsibilities include the supervision of graduate students, as well as teaching at the undergraduate and graduate levels. Based on qualifications, salary range of $75,000 to $155,000 will be considered. Negotiations beyond this salary range will be considered for exceptionally qualified candidates. Effective date of appointment is negotiable. The search is open to all areas of quantum information. The search committee will consider all creative and energetic candidates in any area of research focused on advancing quantum information.

The University of Waterloo is host to the Institute for Quantum Computing. At present, IQC has a complement of 22 faculty members (growing to 33) from the Faculties of Engineering, Mathematics and Science. Interested individuals should upload their application via the faculty application form at: **http://uwaterloo.ca/iqc/positions**.

The application review process will begin on **December 1, 2015** and continue until **March 31, 2016**.

The University of Waterloo respects, appreciates and encourages diversity. We welcome applications from all qualified individuals including women, members of visible minorities, Aboriginal peoples and persons with disabilities. All qualified candidates are encouraged to apply; however, Canadian citizens and permanent residents will be given priority.

Three reasons to apply: **https://uwaterloo.ca/watport/why-waterloo**.

UNIVERSITY OF WATERLOO | IQC Institute for Quantum Computing

Research Assistant Professor

Applications are invited for a Research Assistant Professor position in the Institute for Quantum Computing (IQC) and any department in the Faculties of Mathematics, Engineering and Science. The IQC is a collaborative research institute focused on quantum information, science and technology. Membership in IQC is a five-year appointment, subject to re-evaluation after three years taking into consideration performance and availability of funding. Only those candidates whose research program directly connects with the goals and ongoing research at IQC will be considered. Information about research at IQC can be found at **http://uwaterloo.ca/iqc/research**.

A PhD and significant evidence of excellence in research in quantum information science and technology are required. Based on qualifications a salary range of $70,000 to $90,000 will be considered. Negotiations beyond this salary range will be considered for exceptionally qualified candidates. Effective date of appointment is negotiable.

The University of Waterloo is host to the Institute for Quantum Computing. At present, IQC has a complement of 22 faculty members (growing to 33) from the Faculties of Engineering, Mathematics and Science. Interested individuals should upload their application via the faculty application form at: **http://uwaterloo.ca/iqc/positions**.

The application review process will begin on **Dec 1st** and continue until the position is filled.

IOWA STATE UNIVERSITY

Structural Biology
Assistant Professor

The Roy J. Carver Department of Biochemistry, Biophysics and Molecular Biology at Iowa State University in Ames, IA has embarked on a transformational expansion of its structural biology research enterprise through a large philanthropic gift from the Roy J. Carver Charitable Trust. This major research initiative in Biomolecular Structure includes long-term investment in new instrumentation, endowed funds for graduate student training, and a series of new faculty hires working at the forefront of any aspect of structural biology.

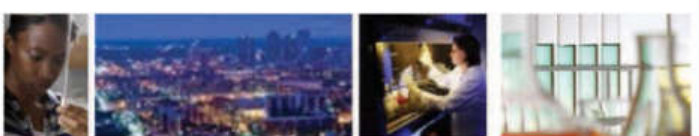
As part of the faculty positions associated with this initiative, and as part of the interdisciplinary effort across the Iowa State University campus to expand structural biology research, the Department seeks a new tenure-track Assistant Professor to establish a vibrant, externally funded research program of international prominence and participate in graduate and undergraduate teaching.

Applicants should have a Ph.D. or equivalent degree, and research accomplishments indicative of the ability to establish an independent research program of national prominence.

To view the entire vacancy #500159 and apply, create an electronic application at **www.iastatejobs.com**

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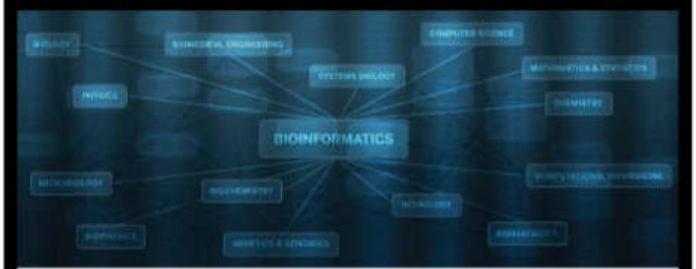
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D E Shaw Research

EDITOR'S PICK



More backing for a citizen's income

From Richard Scrase

There is yet more evidence that paying all citizens an unconditional basic income benefits the country as a whole (3 October, p 28). A two-year pilot project in Namibia paid 1000 residents of two villages about £7 a month. Interim results showed that only 3 to 4 per cent of the total cost of the scheme went on administration (for comparison, I understand that the figure for Jobseeker's Allowance in the UK is 26 per cent). At the same time, the proportion of people experiencing food shortages daily dropped from 30 per cent to 12 per cent over six months; children 's weight for age improved so much that it was nearly on par with the world average; and families were able to send their children to school.

Economic activity rose fastest among women, and average income – excluding the citizen 's income – rose 200 per cent in the bottom fifth of the villagers, because people could now buy things to make themselves more economically productive. Additionally, women could now say no to requests to sell sex.

I suggest we tax robots to pay for a universal citizen's income.
Oxford, UK

To read more letters, visit newscientist.com/letters

We're just as adaptable as ever

From Guy Cox

I was impressed with Michael Slezak's discussion of climate change's role in human evolution, but baffled by its conclusion, that humans are no longer able to adapt to a changing climate (19 September, p 8). This seems to contradict the rest of the article.

Homo sapiens occupies every environmental niche, from the frozen north to tropical rainforest, from the Australian deserts to the Siberian tundra. If we were plants, we would be regarded as weeds. Global warming may not suit *Homo sapiens var Londiniensis*, but then it will be bad news for London too. However the climate turns out, there will be plenty of people for whom it will be just perfect.
Sydney, Australia

What is your city's life expectancy?

From Roy Harrison

John Hunwick notes scientists' statements on climate change often understate the situation, and calls for them to speak out clearly (Letters, 12 September). I would add that they must speak in terms most people can relate to. Saying that there will be a 2 °C or a 4 °C rise in temperature will not get anyone riled. Saying that inland cities in the UK will be lost to the sea should make more impact. It appears that several have a long history (more than 800 years) but a considerably shorter life expectancy (200 years).
East Wellow, Hampshire, UK

Standing on their own four feet

From Charles Nightingale

Sam Wong asks whether dogs' keenness to seek help with problems demonstrates their dependence, or social intelligence (19 September, p 14). There is a more balanced view: that dogs and people have a symbiotic relationship. Sometimes we are dependent on dogs – crossing roads, searching for drugs, getting them to bark at intruders, retrieving hunting kills…
Felixstowe, Suffolk, UK

From Linda Dawe

Did Monique Udell's research into the problem-solving capabilities of dogs and wolves include hounds? Working dogs (such as bearded collies) have been selectively bred for intelligence and obedience; companion dogs for cuteness and affection.

Hounds in contrast are bred for intelligence and independence as a hunting breed. Any basset hound will figure out how to open the baby gate and get into the kitchen to steal food, or to open the garden gate to get at dustbins. Give it a puzzle box with food and see what happens – it won't just crack the code, it'll nip round the back of the lab, find your sack of dog kibble and scoff that too.
Chesham, Buckinghamshire, UK

From Jackie Duckworth

Udell's dogs did not try to open the box until encouraged to do so. Much of the time, initiative is not considered a desirable behaviour in dogs, particularly when it concerns stealing food, and owners are likely to try to suppress it. With encouragement and simple challenges to start with, most dogs can be taught to solve puzzles.
Fulbourn, Cambridgeshire, UK

A fourth good reason for death

From Alec Cawley

Jessica Hamzelou gave three reasons for ageing and death being inevitable (19 September, p 32). There is a fourth: the regular alternation of good times and bad times. When bad times come, it is better if all the population are not at the same level of fitness, since they will starve at the same rate. Having both older individuals of declining fitness and younger individuals to replace them allows death to shrink the population, leaving more resources for those in the prime of life.

When good times return, a group needs to breed fast to reclaim its ecological niche before another steals it – or to steal that of another. It is easier to crank up an active reproduction system into overdrive than one producing only a few replacements for accidental deaths. And an immortal species may forget how to reproduce.
Penwood, Hampshire, UK

Weighing up recovery strategies

From Nick Baker

I was interested to read the proposition that those recovering from injury may adopt a gait that causes them to use less energy (19 September, p 17). Having witnessed my wife recovering from two hip replacements and now coping with a knee problem, I think in her case she modified her gait in order to minimise pain.

However, work I was involved in some years ago showed that adopting lethargic, instead of lively, movement for a given task such as getting up out of a chair could significantly reduce energy use. We identified this as an adaptive action for people under heat stress, in order to minimise thermal imbalance.

In the first case pain has no direct causal relation to energy use, whereas in the second case discomfort, resulting from thermal stress, is directly addressed by limiting energy use.

The key question is: following an operation or injury, does adopting a modified gait help or

"I lost a hero when this came out, but I would rather lose a hero than have this kind of stuff carry on."

David Ward responds to the finding that exoplanet hunter Geoff Marcy violated his institution's sexual harassment policy (17 October, p 6)

hinder recovery? When I broke my heel a physiotherapist told me to consciously avoid limping.
Colchester, Essex, UK

Emotions must come before words

From Jeremy Marchant
Tiffany Watt Smith tackles the interesting subject of whether language helps shape emotions (19 September, p 41). But many writers distinguish between emotions and feelings. Smith seems to use the two words interchangeably.

And presumably English speakers were able to feel *Schadenfreude* before one of them had the bright idea of borrowing the word from German: otherwise there would have been no incentive to borrow, and no way of knowing which word to borrow.

She asks why Germans have two words for disgust, telling us that one of them is "usually translated as revulsion". So, presumably, we also have two words.
Stroud, Gloucestershire, UK

What the imitation game really tests

From Phil Maguire
According to Jacob Aron, Alan Turing "argued that if a computer could fool a person into believing it was a human, it could think" (26 September, p 20). But Turing never sought to define a criterion for what might count as successful fooling. Instead, his view was that there is an inexhaustible supply of finite tests whose unreliability as indicators of intelligence is hard to expose. So, he wrote, "there would be no question of triumphing simultaneously over all machines" by performing some action which machines cannot.

Although intelligence can never be demonstrated with certainty, we can design smart tests that allow it to be detected with high confidence. Machines could in principle also pass these tests, though.

Our understanding of what tests are most reliable will keep changing. Turing's seminal 1950 article is not an invitation to actually run a definitive test. It is a general observation about how intelligence manifests in practice.
Leixlip, County Kildare, Ireland

Confidentiality is vital in medicine

From John Hughes
When I receive medical treatment I expect all my sensitive clinical data to be kept confidential. Yet Thomas Heldt proposes that data from bedside monitoring devices be stored and made available to researchers (26 September, p 27). If he wants such data, he must obtain informed written consent from every patient.
London, UK

The editor writes:
■ Thomas Heldt reminds us that in the US this kind of research falls under the Health Insurance Portability and Accountability Act of 1996, which regulates use and disclosure of "protected health information". His work on hospital-archived data proceeds only after all protected information has been removed, so that researchers cannot identify patients from the records.

What really did for Australian beasts?

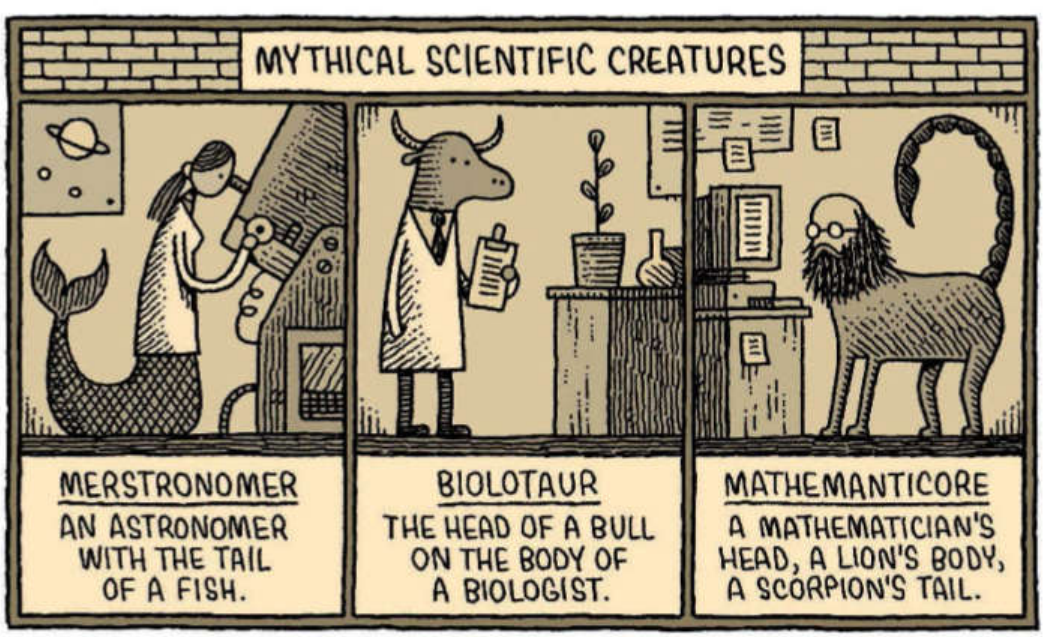
From Alan Watterson
You report Tim Flannery claiming that in Australia, unlike elsewhere, humans rather than climate were responsible for megafauna extinctions (1 August, p 12). There is, however, evidence to the contrary. The fossil record indicates that at most 8 species (13 per cent of the Pleistocene megafauna) were still surviving when humans arrived and that at least 4 species persisted for up to 20,000 years after that. Stephen Wroe and Judith Field in 2006 concluded that climate was the principal cause of megafauna extinction, with human influence "a minor superimposition".
Brunswick Heads, New South Wales, Australia

For the record

■ **As of 2012, the UK Medical Practitioners Tribunal Service hears cases filed by the UK General Medical Council concerning doctors' fitness to practise (10 October, p 4).**

■ **We missed the measure of the NPL, which stands for the National Physical Laboratory. And caesium-133 is the only isotope of this element that is not radioactive; the second is in fact defined by "hyperfine splitting in the ground state" – the frequency of light emitted for a transition between two of its electron states (3 October, p 38).**

TOM GAULD



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Offers will be made to candidates from the fields of biological, chemical, and physical oceanography; marine geology; and ocean engineering. Candidates must be awarded the Ph.D. degree prior to commencing the two-year appointment and start during the 2016 calendar year. Applicants are encouraged to communicate with potential research sponsors at MBARI for guidance on project feasibility, relevance to ongoing research projects, and resource availability (http://www.mbari.org/about/postdoc_mentors.htm).

Application deadline: Wednesday, December 9, 2015

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3. Succinct statement of the applicant's doctoral research
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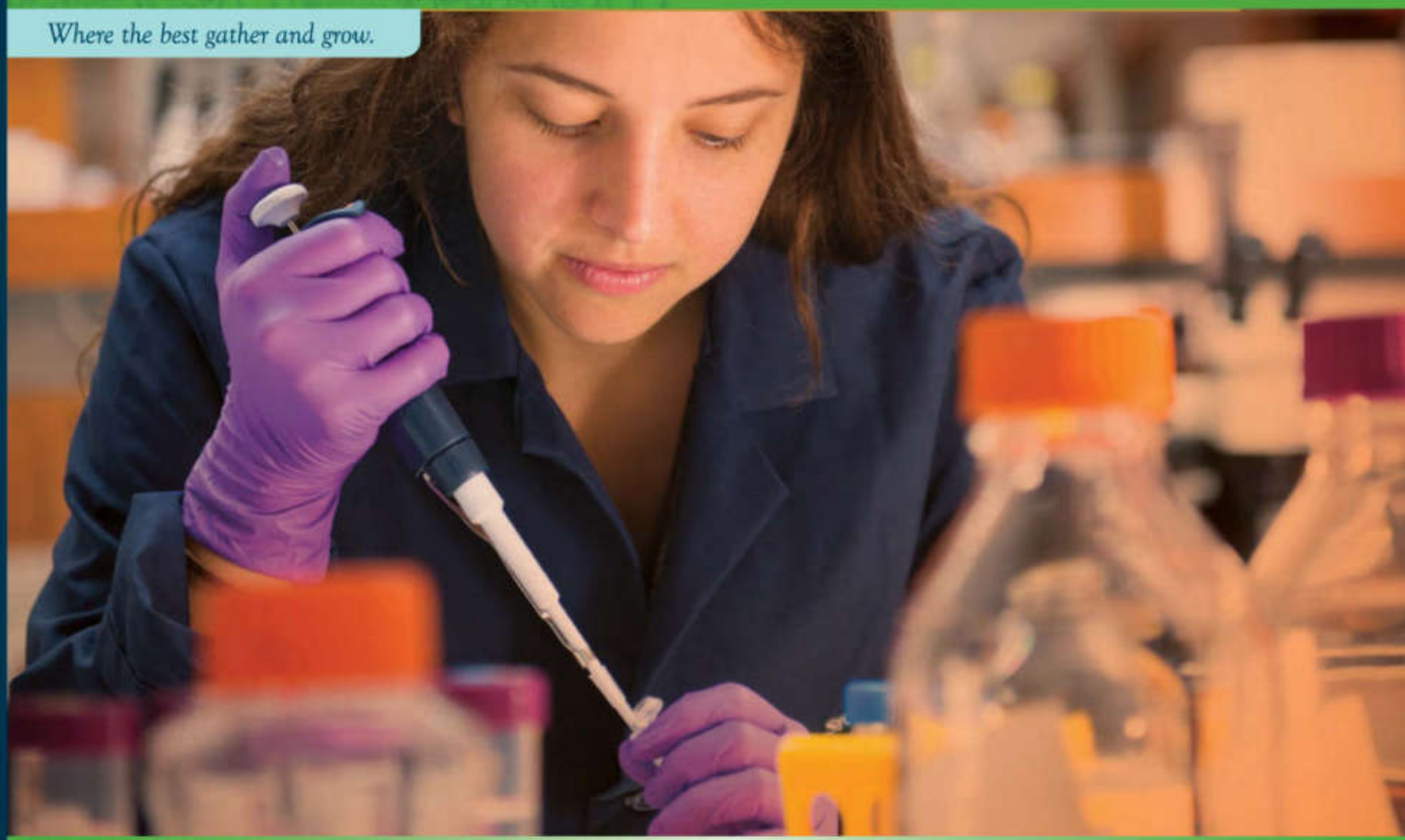


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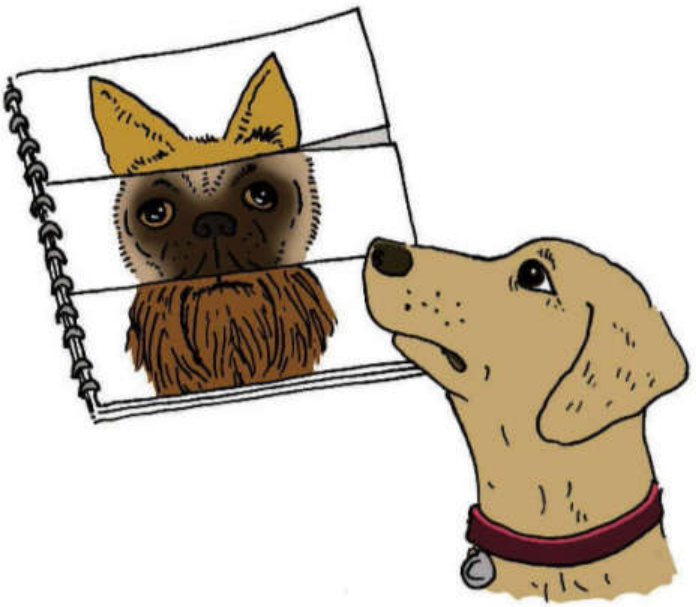
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PAUL MCDEVITT

IT'S a feat that will set tails wagging: facial recognition software that works on dogs. Thierry Moreira at the University of Campinas in Brazil and his colleagues have developed not one but two such systems – named WOOF and BARK – to help match animals in shelters with runaway pets.

The team initially tested three commercial systems that recognise human faces, feeding them photosets of huskies and pugs. All flunked. That brought home to the researchers that "dog facial recognition is not a trivial extension of human facial recognition".

But WOOF and BARK, trained on furry canine faces, did slightly better than a panel of dog show judges and breeders. Still, the researchers say, the successful identification of lost pets will require their owners to be "stimulated to register as many pictures as possible". Given the oft-quoted observation that owners come to resemble their dogs, Feedback wonders if mugshots of the masters will suffice?

FEEDBACK previously discussed feelings that lacked a word to describe them (3 October). Iain McDonald was inspired to write in having realised how damaging it is for those with a genuine condition when people with mild quirks say: "Oh, I'm so OCD."

"Whether it's because we can't stand our playing cards to be crooked on the table, or we have to eat only the blue M&M's, it's not actually OCD," says Iain. "So I've come up with a good term to describe it instead: FauxCD."

A STROKE of genius caressed James Golbey as he accidentally sent an incomplete email on his thoughts about feelings we don't have words for. The follow-up suggested: "The term for sending an email before it was complete ought to be 'e-mal'."

LETTERS continue to flow in defending the scientific credibility of hairdressing (10 October). Roy Smith reports that some years ago, managers at his university sought ideas for new interdisciplinary degrees, and he suggested a BSc in Hairdressing Studies.

"It would have included chemistry (covering hairdressing products and their interactions); life sciences (biology of skin and hair), psychology (concepts of body image and self-expression), sociology (social construction of beauty and fashion), enterprise (running a small business) and communications (advertising and marketing)." In addition, the course could include stints working in salons.

"It sounded pretty intellectually demanding to me, but needless to say, no one wanted 'hairdressing' in our traditional university's academic prospectus," he sighs.

MORE tangled roots: Linda Grant previously defended hairdressing against the charge that it is a "puerile, superficial art". But John Ponsonby says this description is "a curious thing to write, as few think of hairdressing as a boyish activity. Yet puerile is derived from *puer,* Latin for 'boy'." Given that it was gender stereotyping that got our styling tongs warmed up in the first place, Feedback imagines that hairdressing might be more pendantically disparaged as *puellile*.

FEEDBACK searched for the right words to describe statements so stupid they were not even wrong (19 September). Mark Pettigrew writes: "I remember colleagues during job interviews having a coding system for potential candidates. One such was 'EH', used to describe a candidate who was beyond redemption. This stood for East Ham, which any fan of the London Tube will know is 'one stop short of Barking'."

TZU Technologies is a company using a 1998 US patent for teledildonics to sue small firms making high-tech sex toys (28 August). Holland Haptics and Kickstarter were the latest recipients of its unwelcome advances over a crowdfunded product called Frebble, which promises a more genteel kind of congress in the form of remote hand-holding.

Kickstarter wasn't in the mood to take this lying down. Its lawyers made it clear that they would fight the case in court, where the patent's validity could have been challenged. Its confidence wilting, TZU withdrew the suit. A small victory for lonely lovers, though Feedback suspects this isn't the last we'll hear from TZU.

OUR colleague reports that Synology, a firm that makes networked security systems, ended its annual industry conference in London this year with a promotional video best described as a gift from the gods.

While at a trade show in Taiwan earlier this year, a staff member suddenly realised that his laptop had disappeared from the Synology exhibition booth.

Thinking fast, he fired up the company's software and zipped through CCTV footage filmed by the demonstration model over



the previous hour, right up to the moment when the laptop vanished from the booth. Captured there was a clear image of a youth snatching the loot.

The staffer was able to find and confront the culprit before he had time to leave show. So the laptop was restored to its owner, and Synology now has demonstration footage that no amount of money could buy.

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Alaska governor Bill Walker says the state must expand its oil drilling – to pay for the damage caused to local communities by climate change

Light snack

I am a vegan, so my body gets a lot of its vitamin D when I am exposed to the sun. Must the sunshine be absorbed "directly", or can I get the benefit when it arrives through glass windows? How much do I need per day?

Vegan or omnivore, most of us depend on sunlight for meeting our vitamin D needs. And it is not strictly a vitamin because, adequate sunlight can supply your entire requirement without a dietary input.

Estimates of daily requirements vary but UK guidelines suggest 10 micrograms for adults who cannot get enough sunlight, such as those with cultural reasons for covering their body and face, and

"The average daily intake of vitamin D in the UK is poor, somewhere between 2 and 3.5 micrograms"

for elderly people confined indoors. Similar levels are recommended in the US.

Good sources of dietary vitamin D are oily fish, eggs and liver but these are not consumed frequently enough to ensure high intakes. Despite fortification of foods including breakfast cereals and spreadable fats, the average dietary intake in the UK is poor, somewhere between 2 and 3.5 micrograms daily.

A young, fair-skinned adult should be able to synthesise enough vitamin D by exposing their face to the sun for about 20 to 30 minutes, but elderly people and those with dark skin will need more time. Older adults produce about 25 per cent of the levels young adults do for the same length of exposure. The amount of exposed skin is also a variable, so naturists should find it easier to meet their daily allowance.

Sunlight exposure is not, however, as straightforward as it seems, because only the narrow band of ultraviolet B (UVB) light (between 290 and 320 nanometres) is suitable for synthesis of vitamin D in the skin. The further you live from the equator, the harder it is to get an effective dose of sunlight, especially in winter. Winter levels of vitamin D in the blood are half those of the summer.

If your shadow on the ground is longer than you are tall, then you cannot synthesise vitamin D (this is known as the "shadow rule"). In Scotland, for example, early morning sun in December is useless, and there is no significant synthesis of vitamin D between October and March. In summer, it would take someone in London around twice as long to make the same amount of vitamin D as a person sunning themselves in Barcelona, Spain.

But to answer the question, you need to get outside in the summer because little UVB will pass through glass unless you invest in sapphire glass.

It is not possible to overdose on vitamin D from sunlight because erythema or reddening of the skin coincides with its breakdown, so there's no need to go to extremes in the summer. However, in rare cases, too much dietary vitamin D can be harmful, so supplements should be taken with care. Astronauts, submariners and polar workers need supplements for obvious reasons.

Brian Ratcliffe
Emeritus Professor of Nutrition
Robert Gordon University
Aberdeen, UK

This week's questions

MISSISSIPPI MELTER?

Can anyone explain what this odd thing is (see photo)? It was found on a sand beach along the Mississippi river in Minneapolis in early September. It was solid and it had the consistency of a



jellyfish, but appears to have formed along a strand of reed (seen running through the middle) or some other plant-based material.

Andrew Koebrick
Minneapolis, Minnesota, US

A LABOUR LOST?

While perusing my Shakespeare this evening, I wondered if it

"Would trained balladeers of the time have been able to memorise the complete works of Shakespeare?"

would be possible for anyone to accurately memorise the complete works – even if only by rote? Given that prodigious feats of memory were commonplace before we all learned to read and subsequently lost the ability to remember whole sagas at a sitting, would even the highly trained and practised balladeers of the time have had the ability to accomplish this feat (or its equivalent)?

Doug Hunt
Auckland, New Zealand

THUNDER AND LIGHTING

I recently bought a bedside light which is operated by touching the metal base. Several nights ago, during a thunderstorm with much lightning, the lamp came on by itself. Each time I had to turn it off by touching it. How was it turned on?

Michael Pritchard
Dereham, Norfolk, UK

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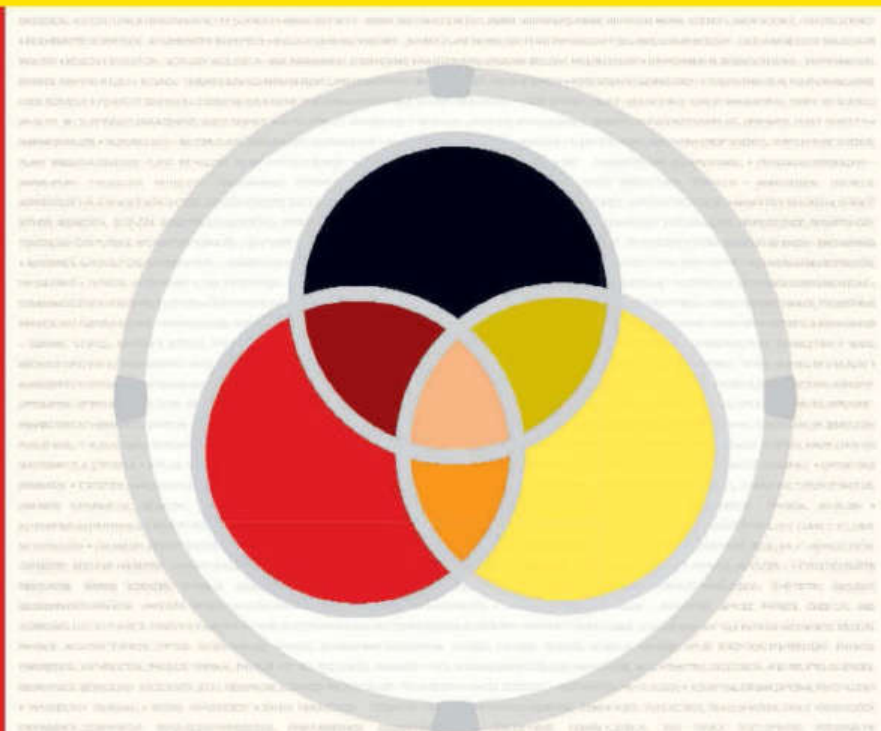
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